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EDITORS:

Prof. F A Ajayi, Prof. I M Haruna, Prof. O. J. Jayeoba

THEME:

Horticulture for Improved Food Security, Sustainable Environment and National Economy Growth

18TH - 22ND NOVEMBER, 2018

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PRESIDENTIAL ADDRESS AT THE OPENING CEREMONY OF THE 36TH ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) HELD AT NASARAWA STATE UNIVERSITY OF AGRICULTUR LAFIA NASARAWA STATE 18TH - 22ND NOVEMBER, 2018.

BY DR H. A. AKINTOYE
PRESIDENT-IN-COUNCIL HORTICULTURAL SOCIETY OF NIGERIA (HORTSON)

His Excellency, Alhaji Tanko Almakura, The Executive Governor of Nasarawa State
Members of the State Executive Council
Honorable Minister here present
Permanent Secretaries here present
Royal Highness
My Lord Spiritual and Temporal
The Vice Chancellor
Management of the University
The Senate of the University
HORTSON Fellows
All invited Guests
Representatives of various media/Press Crew
Ladies and Gentlemen

With great pleasure, I welcome you all to the 36th Annual Conference of the Horticultural Society of Nigeria (HORTSON). This is another landmark occurrence in the life of our Society as we converge in the ancient city of Lafia in Nasarawa State; the nation's "Home of Solid Minerals". We are enjoying the full support of the University with the presence of the Chief Host the Vice-Chancellor, Prof. Suleiman Bala-Mohammed.

The theme of this Conference "Horticulture for Improved Food Security, Sustainable Environment and National Economic Growth" is very relevant and appropriate in the current

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drive of making Agriculture which horticulture is an integral part has an alternative source of earning other than crude oil to increase the Gross Domestic Product (GDP) of the nation. This is indeed timely as the country coming out of recession.

HORTSON is reaching out with numerous publications to disseminate our research findings namely: The Nigeria Journal of Horticultural Science with a new Editor (the latest volume available for launching) and Proceeding of Annual Conference (available at the registration desk).

The proceedings of the 3rd All African Horticultural Congress that was hosted by Nigeria will soon be out as Nigeria has already sent the edited manuscripts to ISHS for publication in ACTA Horticulturae. We are quite happy to inform you also that 13 participants attended this year IHC Congress in Turkey. It is a great improvement on the number that we have recorded in the past.

Also, we are to prepare to attend the 4th All African Horticultural Congress that will be hosted by Senegal in 2020. In addition, the next IHC Congress will be coming up in Japan in 2022. We will want more Nigerians/HORTSON representative in these future events.

The meticulousness and commitment of the members of the Local Organizing Committee (LOC) of this conference is highly commended. There was no communication gap between the Council and the LOC which led to smooth preparation for this conference and for this we are particularly grateful.

The financial and moral support of organizations, the private sector, Fellows of the Society, and individuals to this Conference is highly appreciated.

Thank you all.

LONG LIVE HORTICULTURAL SOCIETY OF NIGERIA,

LONG LIVE NASARAWA STATE UNIVERSITY OF AGRICULTURE LAFIA,

LONG LIVE NASARAWA STATE,

LONG LIVE THE FEDERAL REPUBLIC OF NIGERIA.

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LEAD PAPER ONE

HORTICULTURE ENTREPRENEURSHIP: THE KEY TO SUSTAINABLE ECONOMIC DEVELOPMENT

By

Professor Shehu Abdul Rahman, ***PhD, FNAAE, FHORTSON, FASI***
Professor of Agricultural Economics
Nasarawa State University, Keffi

Abstract

Horticulture is not merely a means of diversification but forms an integral part of food security and poverty alleviation, and also an essential factor of economic development. Horticulture entrepreneurship has important role to play in the areas of human diet, employment, entertainment and medicine to promote sustainable economic development. There are many entrepreneurial opportunities in horticulture with many ways to capture added value in the agricultural value chain. The idea of entrepreneurship in horticulture is complex and dynamic. Skills of entrepreneurs must continue to change to meet the management demands of horticulture enterprises. There are barriers outside the control of entrepreneurs that limit success of horticulture businesses. Specialised training is needed to develop entrepreneurial capacity in horticulture. The extension workers also need specialised training in horticulture to enable them serve as facilitators of entrepreneurship.

* A lead paper presented at the National Conference of Horticultural Society of Nigeria (HORTSON) at Nasarawa State University, Keffi, Faculty of Agriculture, Shabu-Lafia Campus, 19thNovember, 2018.

1. Introduction

Entrepreneurship is a strategic development intervention that could accelerate agricultural transformation process. It stands as a vehicle to improve the quality of life for individuals, families and communities, and to sustain a healthy economy and environment. Development of economy of any nation depends primarily on the important role played by entrepreneurs. Entrepreneurs in developing country like Nigeria have ample opportunities in horticulture, for using innovations to exploit the available resources.

Horticultural sector is strategic in terms of employment opportunities. Rural development programmes are mostly oriented towards creating job opportunities; horticulture development could be the best investment for job creation as one-time investment made in plantation programmes has the potential to provide job opportunities for a long period. The cultivation of fruit plants per unit area of land provides a comparatively larger volume of employment opportunities to the local people than the cultivation of field crops (Nain *et al.*, 2013). Horticulture has great popularity throughout the world.

Nigeria is rich in horticultural production due to its diverse and unique agro-climatic conditions which is conducive for growing wide range of horticultural crops like fruits, vegetables, flowers, spices, nuts, and tuber crops, medicinal and aromatic plants. These horticultural crops have great commercial value as fresh and in processed forms to serve as a good source of foreign exchange. Commercialization of the horticultural crops on a full scale is not yet achieved in Nigeria and there is tremendous potential for the entrepreneurship development in their cultivation. The future looks bright for innovative horticulture entrepreneurs.

2. What is Horticulture?

Horticulture has been defined as the culture of plants for food, comfort and beauty (Arteca, 2015). Horticulture is the branch of agriculture that deals with the art, science and business of edible and ornamental plants. A more precise definition can be given as "the cultivation, processing and sale of fruits, nuts, vegetables, ornamental plants, and flowers as well as many additional services" (Shyr and Reily, 2017). It also includes plant conservation, landscape restoration, soil management, landscape and garden design, construction and maintenance.

In contrast to agriculture, horticulture does not include large-scale crop production or animal husbandry. Horticulture primarily differs from agriculture in two ways. First, it generally encompasses a smaller scale of cultivation, using small plots of mixed crops rather than large fields of single crops. Secondly, horticultural cultivations generally include a wide variety of crops. Horticulture even refers to the growing of plants in a field or garden.

Horticulturists apply their knowledge, skills and technologies to grow plants for human food and non-food uses, and for personal or social needs. Their work involves plant propagation and cultivation with the aim of improving plant growth, yields, quality, nutritional value, and resistance to insects, diseases and environmental stresses. They work as gardeners, growers, therapists, designers and technical advisors in the food and non-food sectors of horticulture.

3. Importance of Horticulture

The horticulture sector has become a key driver for economic development in many countries. The importance of horticulture is widely acknowledged in improvement of the productivity of land, generation of employment, improvement in economic conditions of the farmers and entrepreneurs, and above all, enhancement of exports and nutritional status of food crops. Today, horticulture is popular and important in all societies, both rich and poor. The popularity of horticulture is due to a number of factors. The horticulture industry provides economic value to local communities and to the country. It creates job opportunities. Horticultural practices provide high quality food for people. Also, horticulture offers an increase in aesthetic pleasure that supports psychological well-being.

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Production of vegetable food crops is not only important to our daily nutrition, but also important to economy. Fruits and nuts, like vegetables, are also important to our daily nutrition and economy. Fruit growing is popular, and hundreds of thousands of people are employed in fruit and nut production jobs. A significant level of increase in the labour absorption in fruit cultivation reflects the importance of horticulture in economic development. The major areas of Horticulture that creates employment include:

i) Turf management includes all aspects of the production and maintenance of turf grass for sports, leisure use or amenity use.
ii) Floriculture includes the production and marketing of floral crops.
iii) Landscape horticulture includes the production, marketing and maintenance of landscape plants.
iv) Olericulture includes the production and marketing of vegetables.
v) Pomology includes the production and marketing of fruits.
vi) Viticulture includes the production and marketing of grapes.

4. What is Horticulture Entrepreneurship

Entrepreneurship is a term being used more and more when talking about agriculture. Many stakeholders understand that there is little future for farmers unless they become more entrepreneurial in the way they run their farms. That is, they must increasingly produce for markets and for profits. Horticulture entrepreneurship can be defined as production of various horticultural crops for markets. It is also related to horticultural inputs. It can be described as production and marketing of horticultural inputs and products. Horticulture entrepreneurship is the capacity of farmers/entrepreneurs to introduce innovative techniques in horticultural businesses. It is only the innovative entrepreneur who has the power to transform new situations into thoughts and resolve them into action. Thus, entrepreneurs can play an important role in increasing production and in turn contribute to economic development.

Entrepreneurship contributes to economic development of a country in several ways, like harnessing and assembling the various inputs, bearing the risks, innovating and imitating the techniques of production to reduce cost and increase its quality and quantity, expanding the horizons of the market and co-ordinating and managing the manufacturing unit at various levels. According to Kuratko and Richard (2001) the wealth may be created by individuals who take the major risks in terms of equity, time and career commitment of providing value to some products or services. The product or service itself may or may not be new or unique but value must somehow be infused by the entrepreneur by securing and allocating the necessary skill and resources.

Small-scale farmers can become entrepreneurs when they show remarkable ability to adapt. They look for better ways to organise their farms. They try new crops and cultivars, and alternative technologies to increase productivity, diversify production to reduce risks and increase profits. Many small-scale farmers have some of the qualities of an entrepreneur. Horticulture entrepreneurship involves the following conditions:

i. Seeing farming as a business
ii. Starting appropriate horticulture enterprises

iii. Making farming more efficient, profitable and sustainable
iv. Utilizing land and water resources better
v. Making horticulture attractive to the youths
vi. Capturing value in the agricultural value chain
vii. Introducing high value enterprises to the market
viii. Improving efficiency of external inputs
ix. Promoting organic agriculture
x. Directing more of economic growth towards rural development and alleviation of poverty and malnutrition.

5. Entrepreneurial Opportunities in Horticulture

The following are career options in horticulture

i) Production and sales: Operating a business or managing cultivable land for catering plants and food processing
ii) Public Gardens: Managing landscapes and collecting plants is best for persons interested in both plants and people
iii) Marketing: Involves the sale of fresh or processed fruits and vegetables
iv) Research and development: Developing ways to improve the yield and quality of the plant produce
v) Teaching: Teaching in schools and colleges and to all people who are open to learn new ideas of horticulture
vi) Agricultural engineering: This deals with the conservation of soil and water and farm structures
vii) Landscape design, construction and management: Creating gardens and knowing the appropriate plants to use to achieve the desired aesthetic effect
viii) Pest management: Working with the regulatory agencies, agricultural suppliers, processing corporations, large farm organisation as agricultural specialists

6. Development of Horticulture Enterprises

The idea of entrepreneurship is complex. When a farmer introduces new enterprise into his farming business there are different stages of development that the enterprise goes through. The skills of the farmer must also change and develop to meet the management demands of the enterprise.

The development of horticulture enterprise as a business may occur in five phases:

- Establishment
- Survival
- Early growth
- Rapid growth
- Maturity (and possible decline)

a. Establishment: is usually a quite simple stage but with challenges that relate to market potential, the motivation of the farmer, the availability of resources and basic business skills. The key questions are:
   - How can this become a profitable business enterprise?
   - How will it impact on my farm as a whole?
   - How can I establish a market?

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- Do I have enough money to cover the cash demands in setting up the enterprise? The focus at this stage is on making sure the product is produced, gets to market and is sold. Many new enterprises do not survive the first season of production and marketing. Those that do, enter the survival stage.

b. Survival: inthis stage, the focus is on the relationship between the income earned and the costs entailed. The key questions are:
   - Can I generate enough income to break-even in the short-run and to replace capital equipment?
   - Can I generate enough income to expand or diversify production according to market demands to ensure long-term viability?

   Many surviving enterprises stay in the survival stage. The farmer/entrepreneur will need to consider if he want to do the work to keep growing. If he does, he will need to figure out how to build on the success of the enterprise to move to the next stage.

c. Early growth: if the farmer decides to take his new enterprise beyond survival, the enterprise needs to grow. To achieve this, the farmer needs to develop a broader product and buyer base while ensuring that the farm business remains profitable. He must also ensure that farm operations are efficient, find the information needed for better management and hire more skills staff to cope with the increased production, marketing and management activities.

d. Rapid growth: once the horticulture enterprise is working as a well-integrated farm business, it is in a position where it can achieve rapid growth. One way to grow is by increasing the amount of land planted. This will give more products to sell. Another way is to add value to the product by processing it and/or packaging it.

e. Maturity (and possible decline): Eventually, the horticulture business reaches maturity. This means that it stops growing or expanding. It reaches a point of balance where land size, market opportunities and the scope of activities are in balance with the skills and vision of the entrepreneur. As long as the entrepreneur and the horticulture business continue in this balance the enterprise will continue. If the enterprises are profitable and the farm is well managed, the business can be sustained.

7. The Entrepreneurial Environment

Being an entrepreneur is a way of life and a way of looking at the world. Entrepreneurs enjoy independence and freedom. They decide for themselves what to do and when to do it. Entrepreneurs also face risk, work under pressure and are immediately accountable for the outcomes (good or bad) of their decisions.

Farmers as entrepreneurs are free and independent, but do not work alone. They operate in a complex and dynamic environment. They are part of a larger collection of people including other farmers, suppliers, traders, transporters and processors, each of whom has a role to play in the agricultural value chain. The world of a farmer as an entrepreneur can be referred to as UNCERTAINTY. Figure 1 describes the world of a farmer as an entrepreneur.

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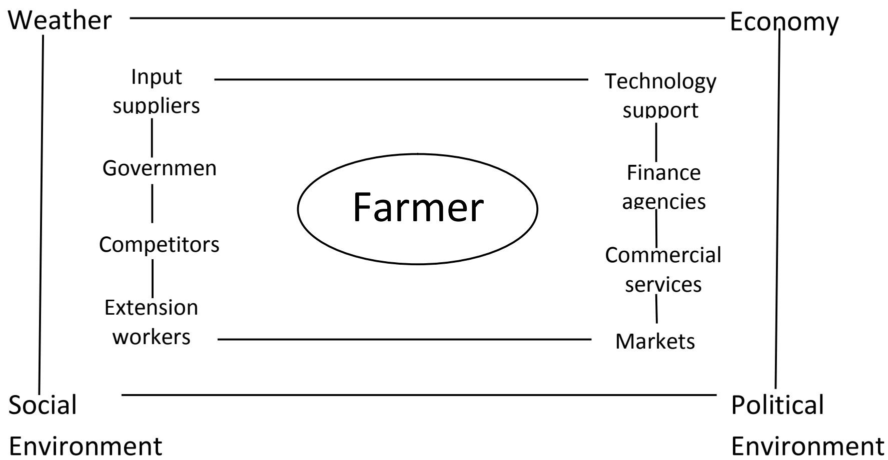

Fig. 1: The world of the farmer-entrepreneur Source: Kahan (2012)

8. Barriers to Horticulture Enterprises

It cannot be assumed that every enterprise will be successful. It needs the right environment. But often there are barriers outside the control of the farmer that limit success and cause inefficiency by making the environment hard for new businesses (Kahan, 2012 and Rahman, 2013). This environment is affected by government policy and the level of investment in agriculture. To create and maintain an environment that encourages profitable, market-oriented farm businesses, policy makers need to address the following barriers:

i. Poor or absent infrastructure: which often block starting and growing of profitable farm businesses. Poor roads leading to markets, inadequate storage and market facilities and irregular supplies of electricity create practical barriers to developing farm businesses.
ii. ii. Unsupportive laws and regulations: Government need to have a positive view of entrepreneurship in farming. Land tenure and ownership, banking laws, trading regulations, business laws and tax laws are some of the common barriers that limit the development of successful farm businesses.
iii. iii. Lack of financial support: is a major stumbling block for many farmers to expand production or diversify into new high value enterprises.
iv. iv. Lack of training facilities: to have a healthy farming sector, training facilities and support must be easily available to farmers. Effective institutions need to be developed to provide education and training at the right time, in the right place, and with the right balance of technical knowledge and practical skills.

Inadequate support services and trained extension staff: Farmers advancing through the five stages of development of enterprise will need information, advice and support. In many countries, there is a general lack of farm management advisors to deal with the range of issues and questions faced by farmer-entrepreneurs.

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v. Marketing constraints: When running a farm business, production must always be linked to a market. Access to market is often constrained by a number of factors.
vi. These include poor communications, infrastructure and marketing facilities, lack of reliable and timely market information, limited purchasing power and even negative attitudes of buyers.

9. **Conclusion**

Many small-scale horticulture farmers have some qualities of an entrepreneur. Farmers as entrepreneurs operate in a complex and dynamic environment. Horticulture entrepreneurship is affected by government policy and level of investment in agriculture. Every horticulture enterprise needs the right environment to be successful. To create and maintain an environment that encourages market-oriented and profitable farm businesses, government and other stakeholders should create enabling environment by providing credits facilities, training of farmers and extension workers, basic infrastructure, Market facilities (especially farmers' markets), adequate fund to agricultural research institutes. Policies should encourage horticultural industry growth through the following:

- Develop potential in the smallholder sector to produce for the export market
- Achieve market diversification to best advantage to promote export competitiveness
- Adopt a least cost strategy for commodity products driven by volume and price
- Adopt a focused differential strategy for niche products
- Review export market requirements (legislation and regulations) to ensure industry compliance
- Identify, adapt and implement internationally accredited phytosanitary inspection and quality control systems
- Encourage contract growing
- Focus on efficient irrigation systems
- Encourage establishment of out-grower post-harvest cold rooms and pack houses

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THE BIOTECHNOLOGY OF HORTICULTURE IN NIGERIA: A FUNDAMENTAL APPROACH TO POVERTY ALLEVIATION AND FOOD SECURITY.

BEING

A KEYNOTE PAPER BY

DR MRS. ROSE S.M. GIDADO

THE COORDINATOR, OPEN FORUM ON AGRICULTURAL BIOTECHNOLOGY(OFAB) IN AFRICA, NIGERIA CHAPTER AT THE 36TH ANNUAL CONFERENCE OF THE HORTICULTURAL SOCIETY OF NIGERIA (HORTSON) (HORTSON), TAGGED LAFIA 2018 WHICH IS SCHEDULED TO HOLD IN NASARAWA STATE UNIVERSITY, KEFFI, FACULTY OF AGRICULTURE, SHABU-LAFIA CAMPUS BETWEEN NOVEMBER 18-22, 2018.

PROTOCOL

Its gives me a great pleasure and privilege to give the Keynote Speech at this epoch making event-The 36th Annual Conference of the Horticultural Society of Nigeria with the theme: "**Horticulture for Improved Food Security, Sustainable Environment and National Economic Growth"**. This theme of course is very apt at this time when Nigeria is taking measures to diversify her economy-moving away from the oil-based (mono-economy)to non-oil based with Mineral resources and Agriculture being on the top list of Mr. President. As laudable as diversification of the economy into Agriculture seems, let me also remind you that the challenges of today's world have brought many pressures to bear on agriculture: Population growth, insects and pests infestation of crops, weed invasiveness, soil infertility, salinity, the impact of climate change (drought and rise in temperature), the need to reduce greenhouse gas emissions, water and energy shortages among several others. These scenario heightens the critical role of innovation to make agriculture a business, more competitive and sustainable. The world's population is estimated to be at about 9.7 billion by 2050 and Nigeria is estimated to be 389 million by 2050. Our agricultural productivity at the moment is 1%. This cuts across all crops including Horticultural crops. If agricultural yields stay the same, we would need to cultivate <u>more than double the present amount of land</u> to feed that population. That's 82% of our total land area on earth.

INTRODUCTION

Horticulture is the science and arts of growing fruits, vegetables, flowers or ornamental plants. The challenges of keeping horticultural production at pace with the escalating population is becoming a concern in Nigeria and the world at large. For example, Mohandas (2018) has reported a proportional increase in the requirement of fruits and vegetables due to the increasing

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population in Nigeria. Despite the considerable progress made by conventional plant breeding techniques in the development of improved varieties, they are not sufficient to keep pace with the increasing demand for vegetables and fruits in developing countries. Therefore, the need to integrate modern technologies like biotechnology to speed up crop improvement programs is pressing (Mohandas, 2018). The Technology Information Forecasting and Assessment Council (TIFAC) (2018) has defined Biotechnology as any technique that uses live organisms viz yeast, viruses, bacteria, fungi, animal cells, plant cells etc. to make or modify products, improve plants or animals or engineer micro-organisms for specific uses.

Modern biotechnology holds considerable promise that can meet the challenges in horticulture (TIFAC, 2018) and transform the entire crop improvement programmes by reducing the use of pesticides and chemical fertilizers, new strains of plants and supply of planting material (Mohandas, 2018). In developed countries, many genetically modified fruits and vegetables are already in the market (Mohandas, 2018). Major biotechnological areas which can be adopted for development of horticultural crops are: Tissue Culture, Genetic Engineering, Molecular diagnostics, Molecular markers, Gene editing, Gene splicing, etc.

Okunlola *et al*. (2016) has reported that horticulture is not formally recognized or promoted as a feasible means of improving urban green space, aesthetics or increasing employment opportunities of urban agriculturalists (Okunlola *et al*., 2016). The neglect of environmental beautification planning across the nation, which, many ornamental plants can inherently be utilized, has resulted in continuous environmental degradation which could be attributed to population pressure (Okunlola *et al*., 2016). This Keynote paper therefore seeks to review how the application of biotechnology in horticulture can lead to national development in Nigeria.

The Link between Biotechnology, Horticulture, Food Security and Poverty Alleviation

Poverty is the principal cause of hunger (World Hunger Education Service, 2013) and a major problem in many developing countries in the world, including Nigeria. It has been described as a vicious cycle, causing hunger and malnutrition. The roots of poverty have been linked to food insecurity, adverse development of international schemes, world economic recession, foreign debt burden, and a series of economic reform (Okuneye, 2001). Friedman (2008) has projected that food issues may become as politically weakening after 2050 as energy issues are today in Nigeria. Currently, Nigeria is facing food crisis, with the population, especially the poor, having inadequate access to quality food (Akinyele, 2010). Sustainable agriculture is a fundamental way by which food insecurity can be addressed (Troeh and Donahue, 2003).

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The International Society for Horticultural Science (ISHS) (2012), has reported that high-value horticultural crops can play a key-role in helping to feed the world with nutritionally healthy food. Horticulture, as part of the specialty crops, represents 50% of the farm-gate value of all crops produced in the US, and, unlike cotton, corn, rice, soybean, and other staple crops, they receive little government subsidy (Davies and Bowman, 2016). While staple cereal crops are needed for their starch and calories, they do not supply the vitamins and minerals found in fruits and vegetables (Davies and Bowman, 2016). There are opportunities for increased vegetables and fruits production and consumption to ensure a diet rich in vitamins and micronutrients (Bowman, 2013).

Then there is the economics of scale: A smallholder farmer can be commercially successful growing high-value horticulture crops under small acreage in rural, peri-urban or urban environments, while hectares are required to farm cereals commercially (Davies and Bowman, 2016). A greater emphasis is needed on high-value vegetables, fruits, and ornamental plants that create jobs and economic opportunities for rural communities, enable more profitable, intensive farming of small tracts of land in urban areas, and employ smallholder entrepreneurs, especially women (Davies, 2014; Konuma, 2013).

Fimer (2012) has underscored Nutrition, Food Security and sufficient family incomes as the major challenges in many parts of the world. Since hunger and malnutrition have been associated with poverty, availability of economic opportunities through horticultural production will not only help family incomes, but also address food security and nutrition (Filmer, 2012). Training women to produce and market horticultural crops in the developing world can also help provide much-needed income stream for families with children (Filmer, 2012). The science of agricultural biotechnology has demonstrated the opportunity to reduce pesticide use and reduce soil erosion, thereby reducing cost of production (Herrera *et al*., 2005). One of the few examples of biotechnology application in horticulture is the Flavr Savr™ tomato with increased shelf life (Sankula and Blumenthal, 2004).

The application of biotechnology for horticultural crop improvement has dawdled significantly behind when compared to agricultural biotechnology products despite the importance of horticultural market and the astounding success of biotechnology in most of the world. The tremendous market penetration numbers of 17 million farmers in 24 countries planting biotech crops in 189.8 million hectares of land reported by James (2017) shows that farmers have a high level of confidence in these crops. From 1996 to 2016, economic gains of US$186.1 billion at the farm level were generated globally by biotech crops, due to reduced production costs and substantial yield gains. Biotech crops have reduced the amount of pesticides used by 670 million kilograms. In 2016 alone, fewer insecticide sprays reduced CO_2 emissions by 27.1 billion kilograms, equivalent to taking 16.7 million cars off the road for a year. Runge and Ryan (2017), clearly showed that farmers have recognized the benefits of biotechnology. However, these benefits extends beyond value to agriculture.

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The Impact of Biotechnology in Horticulture: Case study of developed countries

Twenty years ago, consumers only ate fruit that was "in season." Fruit was not shipped long distances and supply was dependent on local production areas. Demand for year-round, inexpensive produce has led to consolidation of production where temperatures are warm, sunshine is plentiful, and labor is cheap. In most cases, produce is now shipped long distances before being consumed. Tomatoes grown in Mexico are trucked 3,500 miles, bananas grown in Ecuador travel 6,000 miles on a boat, bell peppers from Holland greenhouses are flown 5,000 miles to market. Unfortunately, fruit was not designed to be shipped long distances. In order to make it to market, fruit was picked before it was ripe (and before it has any taste). Despite harvesting immature fruits, post-harvest losses of fruits and vegetables still exceed 25 percent of crop production and the fruit that makes it to market has often been described as tasteless.

Factors Militating against the Progress of Horticultural Biotechnology in Nigeria

Though horticultural crops are of high economic importance, each crop represents only a small segment of a market that consists of hundreds of cultivars representing many different species (Robert *et al*., 2006). In comparison to large acreage field crops like maize and soybean, horticultural crops have limited investment in research for biotech improvements due to their lower economic value (Alston, 2004). While several traits are still untapped due to the lack of effective technology, proven technology exists to develop biotechnology-enhanced products that would have real producer and consumer value. However, the cost to develop a regulatory petition and commercial launch delays are particularly difficult for those trying to develop specialty crops due to smaller market size (Robert *et al*., 2006). Thus, the high cost of biotechnology (Alston, 2004) coupled with limited market returns for individual crops make investing in horticulture biotechnology a more difficult business decision (Robert *et al*., 2006).

The way forward

It is evident that horticultural biotechnology must be adopted if food security and poverty alleviation must be attained in Nigeria. The Government of Nigeria should therefore advance the horticultural sector through consistent policy making and implementation, holistic adaptation strategy and proper funding.

I am hitherto, excited that Horticultural Society is a formidable platform for dialogue on the transformation of Horticulture in Nigeria through quality information dissemination on Horticulture. It is therefore, imperative to let the stakeholders here to learn about the use biotechnology to transform horticultural science. Nigeria cannot be left out in this arena. She needs to use biotechnology to create wealth/jobs, eradicate poverty, improve agricultural productivity and crop yields, and enhance foreign exchange earning potentials.

Agricultural research institutes therefore have an obligation to address forecasted growth in food demand and the need to provide a sustainable, safe and secure food supply for the nation and to assist in creating viable and sustainable agro-food sectors. It is essential that we come to terms with the fact that modern agricultural innovations are part of the solution rather than the problem. This is why public investment in modern agricultural research and innovation is so important.

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Joint programming Initiatives, and Innovation partnerships, will be instrumental in achieving a better coordination of these efforts.

State Government also need to recognize the need to support all agricultural research institutes and discourage politicizing implementation of agricultural projects. Our efforts to ensure that Agriculture ceases from being treated as a development programme but as the country's business and the only means of survival is one we are not relenting on.

Conclusions

Increased production of horticultural crops provides the opportunity to reduce malnourishment, hunger, and poverty. It also generates employment and niche market opportunities for smallholder farmers on small acreage. In contrast to field crops (e.g., corn, wheat, rice, sorghum), which require larger land availability for economies of scale, horticulture can be profitable under reduced acreage.

Finally, Distinguished Ladies and Gentlemen, the call for diversification of the Nigerian economy should not be seen as government's responsibility alone. We all have a stake in it and must all cooperate and collaborate with the Federal Government and relevant agencies both public and private to make our diversification into agriculture smooth and easy. OFAB Nigeria is also ready to partner with the Society in the area of awareness creation. I stand in favor of using seeds and products that have a proven track record, special case needs to be made for those who are skeptical. There is a big gap between what the facts are and what the perceptions are. As I look around here this morning, with the impressive array of stakeholders especially eminent scientists, journalists, industrialists, farmers etc, I leave you with one message: biotechnology remains a verified engine of growth!

Wishing you have a successful Conference!!!!!!!

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Effects of Sowing Dates on the Growth and Yield of Cowpea Varieties in Minna, Southern Guinea Savanna of Nigeria.

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Abstract
With climate change being experienced in recent times, there is the need to determine the most appropriate time to plant cowpea in the Guinea savanna agro-ecological zone of Nigeria which account for the major production of the crop in the country. A field trial was therefore conducted to determine the effect of sowing dates on the growth, biomass and grain yield of cowpea in Minna, the Southern Guinea savanna agro-ecological zone of Nigeria. The treatments consisted of nine sowing dates (planting at 2 weekly intervals from 19th May to 8th September, 2017) and three cowpea varieties (IT93K-452-1, Oloyin and Kanannado). Results obtained revealed that plants sown between 19th May and 28th July had significantly larger leaf area than those sown later. Plants sown on 2nd June had the highest number of branches which was at par with the value recorded in those sown on 19th May and 16th July. Plants sown on 28th July had the highest number of leaves while plants sown between 19th May and 2nd June had the longest vines. The widest stems were observed in plants sown on 19th May and they were significantly wider than the stem of plants sown after 14th of July. The least values for all the growth attributes were recorded in plants sown on 8th September. Kannanado and Oloyin plants sown on 19th May produced the highest biomass yield while IT93K-452-1 variety produced the highest biomass yield when sown on 2nd June. Kanannado variety had the highest grain yield when sown on 28th July. Oloyin and IT93K-452-1 varieties had their highest grain yield when sown on 19th May and 1st July. Significantly lower grain yield was obtained in the three varieties when sown after 11th August. Among the varieties, Kanannado had the highest biomass yield but the least grain yield while IT93K-452-1 had the highest grain yield.
Key words: *planting dates, cowpea varieties, growth, biomass yield, grain yield*

INTRODUCTION

Cowpea (*Vignaunguiculata* L. Walp.) is an important grain legume and a long time valued constituent of the traditional cropping systems in the semiarid tropics (Van Ek*et al*., 1997; Ayisi*et al*., 2000). It is an important food source in the tropics in general and Nigeria in particular, a valuable crop for farmers economic wellbeing (Ajetomobi and Abiodun, 2010). One of the most important factors determining the yield of cowpea is the right sowing date. In general, climate parameters such as temperature, rainfall, day length, wind, and non-climate factors such as pests, diseases, weeds, birds, economy of production are effective in selecting appropriate sowing date (Mazaheri and Majnoon, 2005). Of all these, rainfall is the major determinants of sowing dates in West Africa agriculture which is mainly rain fed. However, climate change facing the whole world and affecting Africa more seriously is changing rainfall pattern and shortening growth season to the extent that area earlier suitable for growing a particular crop may no longer be suitable (Lane and Jarvis, 2007). During the last 30 years, the climate of the West African Sahel has undergone various changes, especially in terms of rainfall (Van Duivenboode*et al*., 2002; Roudier*et al*., 2011). As such, West Africa agriculture which is mostly rain fed is most vulnerable to the impact of climate change. Nigeria is one of the largest producer and consumer of cowpea which is mostly produced in the savanna region of the country. Farmers in this region are used to the traditional planting date of planting their cowpea just before dry

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season sets in; this has not been delivering the expected yield. The potential yield of the crop is 1.50 – 3.00 t ha^{-1} depending on the variety (Asiwe, 2007) but yield obtained by farmers in Nigeria is averaged at 450 kg ha^{-1}(Omotosho, 2014). Inappropriate planting date has been identified as one of the factors responsible for the low yield obtained on farmer's field (Kyei-Boahen, 2017).This has a devastating consequences for the poor-resource farmers who depend mainly on rain fed agriculture (Van Duivenbooden*et al*., 2002). Production of cowpea was predicted to fall up to 30% by 2025 (Van Duivenbooden*et al*., 2002).Various strategies should be employed to lessen this potential loss and increase the productivity of the crop. In a research by Ajetomobi and Abiodun (2010), earlier sowing date beyond traditional dates was suggested. This is already a pointer to the fact that planting cowpea close to onset of dry season may not be the best. Asante *et al*., (2001) investigated the impacts of sowing dates in reducing yield losses due to insect attack in the Northern Guinea Savanna of Nigeria. The authors reported that elite cowpea lines had higher grain yield when planted between mid-June and mid-July without insecticide protection, whereas a local variety included in the study produced higher grain yield when planted between late July and early August. Determining the best sowing date for cowpea in the face of climate change with cultivar and location specific information will secure Nigeria's relevance as one of the major producer of cowpea. This study was therefore carried out to determine the effects of sowing dates on the growth and yield of cowpea varieties (with different maturity period) in Minna, southern Guinea savanna agro ecological zone of Nigeria.

MATERIALS AND METHODS

The experiment was carried on a farmer's field in Minna, southern Guinea savanna agro ecological zone of Nigeria. The geographical positioning system (GPS) value of the farm is N $09^0$31.203 and E $06^0$27.678. It was a factorial combination of nine planting dates (planting at two weeks interval) viz: 19th May, 2nd June, 16th June, 1st July, 14th July, 28th July, 11th August, 25th August, and 8th September and three cowpea varieties viz: Kanannado (late maturing), Oloyin (medium maturing) and IT93K-452-1 (early maturing). The 18 treatment combinations were laid out in a randomized complete block design with three replications. Plants received 20 kg P ha^{-1} and 20 kg K ha^{-1} at planting using single super phosphate and muriate of potash as the sources respectively. The gross plot size was 11.25m^2 (3.75 x 3m) while the net plot size was 6.75m^2. Data were collected from the net plot. Intra and inter-row spacing of 20 x 75cm was maintained except for Kanannado variety in which 30 x 75cm was maintained because it was a prostrate variety. Data were collected on number of leaves, vine length, stem diameter, leaf area at 7 weeks after planting, number of branches, shoot biomass and below ground biomass yield at 50% flowering and pod yield, number of seed per pod, pod length, 100 seed weight, shelling percentage and grain yield at maturity. Meteorological data were obtained from the Geography Department, Federal University of Technology, Minna.

Data collected on all parameters were subjected to analysis of variance using statistical analysis system (SAS) and means were separated using Duncan Multiple range test at P=0.05

RESULTS

Effect of planting dates on the growth attributes of three cowpea varieties

Plants sown on 28thJuly had significantly higher number of leaves (78.73 leaves) followed by those sown between 2nd of June and 1st July (48.34 - 50.50 leaves). From 11th July, number of leaves reduced significantly as the planting date advanced with the least recorded in plants sown on 8th September (19.66). Kanannado variety produced significantly higher number of leave (54.76 leaves) compared to Oloyin (50.06 leaves) and IT93K-452-1 (50.17 leaves) varieties that were statistically at par (Table 1).

The leaf area of plants sown on 19th May, 2nd June, 1st and 14th of July were similar (183.49 – 196.34 cm^2) but significantly higher than those obtained in the remaining sowing dates. Leaves of plants sown between 11th August and 8th September were the smallest (82.80 - 92.77 cm^2). Though Kanannado leaves were larger, there was no significant difference between leaf area of the three varieties at 7 WAS (Table 1).

Plants sown on 2nd of June produced the longest vine (219.10 cm). This was followed by those sown on 19th May and 11th August which had similar vine length (172.93 and 176.34 cm respectively). The shortest vine was recorded in those planted on 8th of September (38.11 cm) Kanannado variety had the significantly longest vine (130.15 cm) and the values obtained in Oloyin (115.05 cm) and IT93K-452-1 (112.85 cm) were at par (Table 1).

Plants sown on 19th May, 2nd June, 16th June and 14th July had similar but statistically higher stem diameter (1.56 cm) compared to those sown from 28th July up to 8th September. There was no significant difference between the stem diameters of the three varieties (Table 1).

Plants sown on 2nd June, 19th May and 16th June produced similar but significantly higher number of branches compared to the number of branches recorded in plants sown on 8th September. Kanannado variety produced significantly higher number of branches compared to those of Oloyin) and IT93K-452-1 that were at par (Table 1).

Effect of planting dates on the biomass yield of three cowpea varieties

Figure 1 shows the interaction effect of planting date and variety on shoot biomass yield of cowpea. Kanannado variety had the highest biomass yield (15 t ha^{-1}) when planted on 19th May. This was followed by the yield obtained in plants sown on 1st July (10.63 t ha^{-1}) which was at par with the shoot biomass yield obtained in plants sown on 16th June (8.65 t ha^{-1}). Plants sown between 11th August and 8th September had the least biomass yield (1.04 - 2.92 t ha^{-1}). Oloyin variety sown between 19th May and 16th June had significantly higher biomass yield (5.61 – 7.97 t ha^{-1}) than those sown between 14th July and 8th September which had similar low shoot biomass yield (1.11 – 2.99 t ha^{-1}). IT93K-452-1 plants sown on 2nd June had the highest shoot biomass yield (8.72t ha^{-1}). This was at par with the value obtained in plants sown on 19th May (8.03 t ha^{-1}). IT93K-452-1 plants sown after 1st July had similar low shoot biomass yield (1.15 - 3.53 t ha^{-1})

Table 2 shows the below ground biomass weight of three cowpea varieties sown at different planting date. In Kanannado variety, plants sown on 2nd June had the highest below ground biomass weight (15.02 g/plant) which was at par with the value recorded in plants sown on 19th May (14.64 g/plant) and 28th July (11.84 g/plant). The value recorded in plants sown between 16th June and 14th July were intermediate and similar (8.86-10.38 g/plant). The least values in Kanannado variety was recorded in plant sown on 8th September (1.70 g/plant) which was at par with the value recorded in plants

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sown on 25th August (4.88 g/plant) and 11th August (3.52 g/plant). In Oloyin and IT93K-452-1 varieties, plants sown on 19th May, 2nd June and 1st July had the highest below ground biomass yield compared to plants sown between 14th July and 8th September which had similar but lower below ground biomass yield. In the three varieties, plants sown on 8th September had the least below ground biomass yield.

Effect of planting dates on the grain yield attributes of three cowpea varieties

Generally, plants sown on the 25th August produced the longest pods (16.48 cm). This was however at par with values obtained in other planting dates except those planted between 16th June and 14th July which had the shortest pods (13.40 – 14.74 cm). Pods of Kanannado variety were the longest (16.65 cm) and the values obtained in Oloyin (14.92 cm) and IT93K-452-1 (14.71 cm) were at par (Table 3).

Plants sown on 19th May, 2nd June, 16th June, 28th July, 11th August 25th August and 8th September produced significantly heavier seeds compared to those sown on 1st and 14th July. Kanannado seeds were the heaviest (19.77 g). This was followed by Oloyin seeds (16.50 g) and IT93K-452-1 that had the least weight. (13.87 g) (Table 3).

Plants sown on 2nd June had the highest shelling percentage (32.75 %). This was followed by plants sown on 11th August (25.76 %) which had similar values with the shelling percentage obtained in plants sown on other planting dates except those sown on 19th May which had the least value (17.23%). There was no significant difference between the shelling percentage of the three varieties (Table 3).

Plants sown on 19th May, 2nd June, 16th June, 1st July, 28th July and 11th August produced similar but higher pod yield (kg ha^{-1}) compared to those sown on other dates. The least pod yield was obtained in plants sown on 25th August and 8th September (449.0 and 505.0 kg ha^{-1} respectively). IT93K-452-1 variety had the highest pod yield (1,637.5 kg ha^{-1}), followed by Oloyin (1,261.4 kg ha^{-1}) and Kanannado variety had the least pod yield (508.7 kg ha^{-1}) respectively (Table 3).

Plants sown on the 19th May, 16th June, 1st July, 28th July and 11th August, produced similar but higher grain yield (kg ha^{-1}) compared to those sown at other dates. IT93K-452-1 variety produced significantly the highest grain yield (1,257.90 kg ha^{-1}) followed by Oloyin (975.34 kg ha^{-1}) and Kanannado had the least (389.22 kg ha^{-1}) (Table 3).

Figure 2 shows the interaction between planting date and variety on grain yield of cowpea. In Kannanado variety, plants sown on 28th July had the highest grain yield (997.99 kg ha^{-1}). The value was at par with the grain yield of plants sown on 11th August (637.34 kg ha^{-1}). The least grain yield in Kanannado variety was obtained in plants sown on 14th July (114.94 kg ha^{-1}) which was at par with the grain yield of plants sown on 19th May, 1st July, 25th August and 8th September. Oloyin variety sown on 19th May had the highest grain yield (1506.11 kg ha^{-1}) and the value was at par with the grain yield obtained in plants sown on 1st July, 16th June, 14th July and 11th August. The least grain yield in Oloyin variety was obtained in plants sown on 8th September (365.15 kg ha $^{-1}$) which was at par with the value obtained in plants sown on 25th August (429.67 kg ha^{-1}). In IT93K-452-1 variety, plants sown on 19th May had the highest grain yield (2013.50 kg ha^{-1}) which was at par with the value obtained in plants sown on 1st July (1927.11 kg ha^{-1}). The least grain yield in IT93K-452-1 variety was obtained in plants sown on 25th

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August and 8th September (486.79 and 570.82 kg ha^{-1} respectively).

DISCUSSION

The significantly lower biomass and grain yield obtained in the three varieties at late sowing (25th and 8th September) in this study could be attributed to the lower amount of rainfall the plant sown late received. Plants sown on August 25th received 208 mm rainfall and those sown on 8th September received lesser amount. This is low compared to the minimum of 400 mm and well distributed rainfall required for optimum growth and productivity of cowpea. Rainfall stopped early in 2017 cropping season with the last rainfall experienced on October 19th in the study area compared to earlier years where rainfall was still experienced till November. This confirms that climate change is becoming a serious threat to crop productivity even in the study area. Morakinyo and Ajibade (1998) asserted that both the amount and distribution of rainfall affect the productivity of cowpea. This could be a pointer to farmers in the southern guinea savanna that the traditional practice of planting cowpea late (till September) may not be worthwhile again. Ezeaku*et al*. (2015) confirms that climate change has caused significant modification of cropping seasons in different regions. The results obtained in this study corroborates the findings of Ezeaku*et al*. (2015) who reported that late planting dates of cowpea gave significantly lower yield than early planting date in the derived savanna of Nigeria. Yannick *et al.* (2014) similarly reported that late sowing led to slower growth and lower yield of cowpea. Mojaddam and Nouri (2014) reported that delay in sowing of cowpea decreased the length of vegetative and reproductive growth stages and reduces the grain yield of cowpea. Sreelatha *et al.* (1997) attributed the decrease in grain yield obtained in delayed sowing to the fact that plants' vegetative stage faces intense heat of the season which resulted in decreased vegetative growth stage, production of fewer vegetative organs, decreased assimilation, early flowering, increased in loss of flowers and infertility, and decrease in grain yield components in french bean. The significant differences in the growth and yield performance of the three varieties in response to planting dates could be attributed to the genetic differences in the varieties. Akande (2007) reported that planting dates and climatic factors of a place interacts with cultivar and its trait thereby affecting crop productivity. In contrast to the other two varieties, Kanannado variety sown on 19th May yielded low (175.51 kg ha^{-1}) compared to the maximum yield recorded in the same variety when sown on 28th July (997.99 kg ha^{-1}). This could be attributed to the long days to maturity and photoperiod sensitivity of the variety. The vegetative phase of Kanannado plants sown early was prolonged and vigorous at the expense of the reproductive phase. This is evident in the significantly higher biomass yield of Kanannnado plants sown early (15.27 t ha^{-1}) compared to the grain yield (0.18 t ha^{-1}) obtained. This confirms the report of Dudge*et al*. (2009) who reported that when cowpeas are planted early, photosensitive varieties will not flower but grow very leafy and yield may be reduced. This further shows the importance of planting cowpea at the most appropriate time. The significantly highest grain yield obtained in IT93K-452-1and Oloyin plants sown on 19th May (2013. 50 and 1506.11 kg ha^{-1} respectively) in this study allays the fear of farmers that cowpea cannot be planted early in the southern guinea savanna.IT93K-452-1and Oloyin sown on 19th May matured before the peak of

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raining season because they are day-neutral and relatively early maturing especially IT93K-452-1 variety compared to Kanannado variety. However, it is important to note that the pods of plants sown early were picked more frequently as soon as they mature after which they were dried as against the farmers' practice of harvesting all the pods at the same time when all the pods mature. This was to prevent rottening of the pods which account for the major grain yield loss in early sown cowpea This actually may be laborious but it may be compensated by the high yield obtained.

Conclusion

The highest biomass yield in the three varieties was obtained when plants were sown early. Kanannado plants sown on 28th June had the highest grain yield while IT93K-452-1and Oloyin plants sown on 19th May had the highest grain yield which was at par with the values obtained when sown on 1st July. This study has confirmed that the traditional planting date used by farmers in the study area is not delivering the potential yield of cowpea. It can therefore be recommended that photoperiod sensitive and late maturing varieties like Kanannado should be planted around 28th July and day-neutral and early to medium maturing varieties like IT93K-452-1 and Oloyin varieties can be planted around 19th May (as soon as rain gets well established) or around 1st July for maximum grain yield. Planting after 11th August is not recommended in the study area if similar rainfall pattern is experienced. It is therefore important that farmers are adequately informed about accurate weather predictions before the onset of farming season to guide them appropriately on when best to plant.

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Table 1: Effects of planting dates on the growth attributes of cowpea varieties

Planting date	Number of leaves	Leaf area (cm^2)	Vine length (cm)	Stem Diameter (cm)	Number of branches
19th May	42.27c	183.49ab	172.93bc	1.56a	4.58ab
2nd June	50.50b	191.06ab	219.10a	1.45ab	5.29a
16th June	40.43b	152.20c	151.36c	1.49a	4.40abc
1st July	48.34b	196.34ab	76.36ef	1.29bc	3.74bcd
14th July	26.34e	198.65a	54.14fg	1.52a	3.40de

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28th July	78.73a	179.00b	100.55d	1.30bc	3.56cd
11th August	33.15d	92.77d	176.34b	1.19c	4.35bc
25th August	25.53e	90.57d	85.25de	1.27c	3.60cd
8th September	19.66f	82.80d	38.11g	1.14c	2.59e
SE $\pm$	1.72	6.20	8.08	0.06	0.32
Variety (V)					
Kanannado	54.76a	157.04	130.15a	1.35	4.94a
Oloyin	50.06b	147.46	115.05b	1.36	3.49b
IT93K-452-1	50.17b	151.12	112.85b	1.36	3.41b
SE $\pm$	0.10	3.58	4.67	0.03	0.18
P x V	NS	NS	NS	NS	NS

Means with dissimilar alphabets within the same attribute and factor are significantly different using DMRT at P=0.05, NS- Not significant at P=0.05

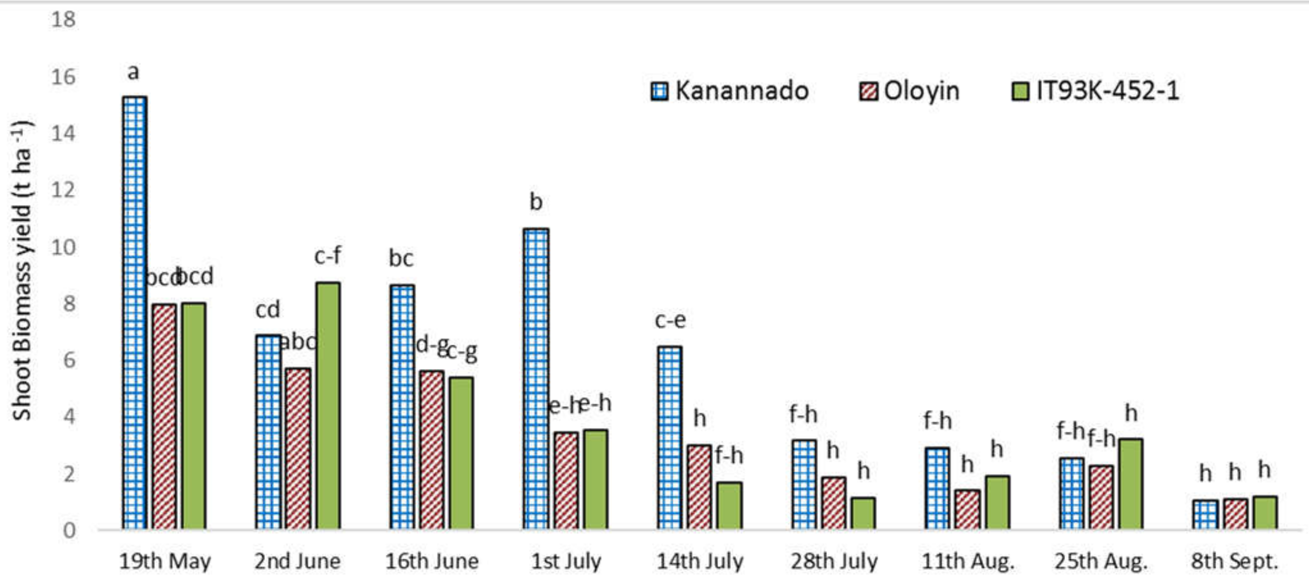

Figure 1: Shoot biomass yield of three cowpea varieties sown at different planting date

Means carrying similar alphabets are not significantly different according to DMRT at P=0.05

Table 2 : Below ground biomass weight (g/plant) of three cowpea varieties sown at different planting date

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Planting date	Variety Kanannado	Oloyin	IT93K-452-1
19th May	14.64a	8.19b-e	8.44b-e
2nd June	15.02a	6.35d-g	7.39c-f
16th June	10.38bc	5.80d-h	5.66d-i
1st July	9.20bcd	5.88d-h	5.96d-h
14th July	8.68b-e	3.83f-j	2.19hij
28th July	11.844ab	3.36g-j	2.87g-j
11th August	3.52f-j	3.90f-j	3.85f-j
25th August	4.88e-j	2.27hij	3.38g-j
8th September	1.70j	2.26hij	1.88ij
SE+		1.38	

Means with dissimilar alphabets are significantly different using DMRT at P=0.05, SE-standard error of the mean.

Table 3 : Grain yield attributes of cowpea varieties as affected by planting date

Planting date	Pod length (cm)	100 seeds weight (g)	Shelling	Pod yield (kg ha^{-1})	Grain yield (kg ha^{-1})
19th May	16.08ab	17.20a	17.23d	1493.5a	1231.70a
2nd June	15.36abc	17.32a	32.75a	1245.3ab	840.80b
16th June	14.74bcd	16.95ab	24.14b	1311.7ab	1004.90ab
1st July	14.06cd	15.76b	22.25bc	1512.0a	1185.10a
14th July	13.40d	13.95c	21.17bcd	1003.2b	793.60b
28th July	16.31a	17.74a	18.74cd	1280.8ab	1036.90ab
11th August	16.30a	17.54a	25.76b	1372.2a	1003.60ab
25th August	16.48a	17.06ab	21.93bcd	449.0c	392.60c
8th September	16.11ab	16.92ab	24.92b	505.0c	378.20c
SE+	0.49	0.50	1.72	123.72	99.62
Variety (V)					
Kanannado	16.65a	19.77a	22.99	508.7c	389.22c
Oloyin	14.92b	16.50b	22.78	1261.4b	975.34b
IT93K-452-1	14.71b	13.87c	23.86	1637.5a	1257.90a
SE+	0.28	0.28	8.07	71.44	57.52
P x V	NS	NS	NS	NS	*

Means with dissimilar alphabets are significantly different using DMRT at P=0.05, SE- standard

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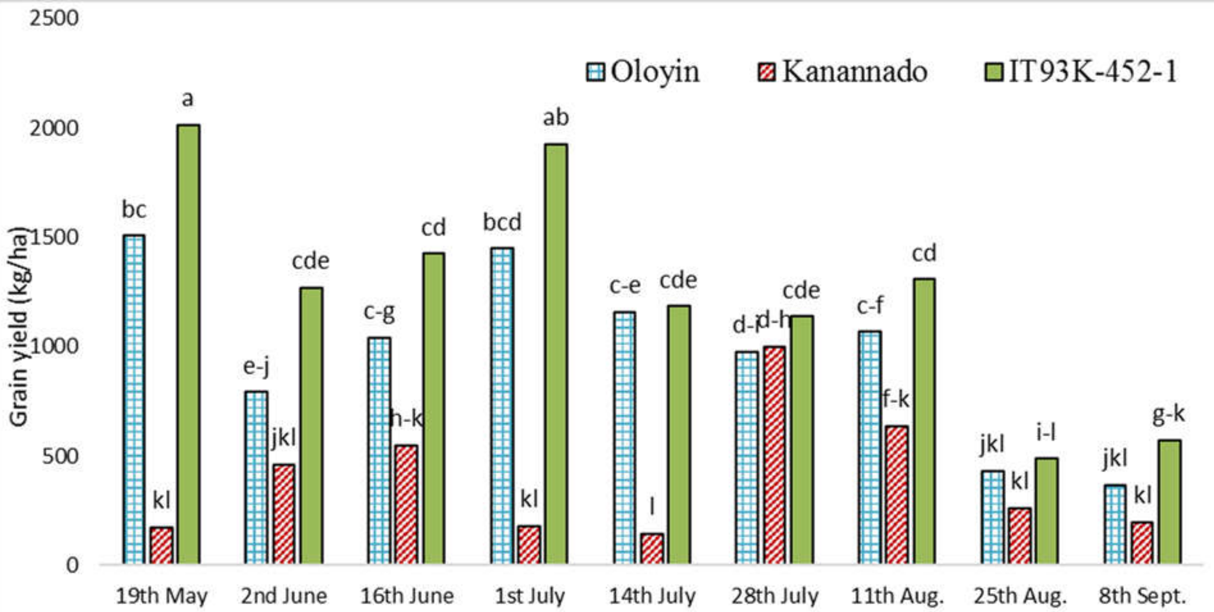

Figure 2: Interaction effect of planting date and variety on grain yield of cowpea

Means carrying similar alphabets are not significantly different according to DMRT at P=0.05

Table 4: Monthly meteorological data for 2017 cropping season

Months	Total Rainfall (mm)	Relative Humidity **(%)**	Min. Temp. **(°C)**	Max. Temp. **(°C)**
May	172.80	67.17	24.52	36.60
June	171.00	72.74	23.60	30.05
July	243.00	76.74	23.17	31.00
August	210.40	81.78	22.21	30.69
September	130.20	73.62	21.24	30.66
October	24.40	75.60	21.25	33.26
November	0.00	49.49	19.50	36.45

Source: Department of Geography, Federal University of Technology, Minna

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Preliminary Characterization of Selected Pepper (*Capsicum annum* L.) Genotypes in South West Nigeria

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Abstract
Pepper is the king of all spices and consumers' preference for pepper fruits ranges in sizes, shapes, and colour. The aim of this study was to characterize five pepper genotypes under field condition. The field evaluation was carried out at the Research Farm of National Horticultural Research Institute, Ibadan. The selected lines were planted out in a randomized complete block design with three replicates and data were collected for days to 50% flowering, plant height, fruit length, fruit weight, fruit yield per plant and matured fruit colour. NHPJ-2 had the longest fruit length (12.3cm) and was also the earliest to attain 50% flowering while NHPJ-4 had the highest plant height. The highest fruit yield per plant was recorded for NHPJ-1 with a distinctive yellow colour at maturity. Based on the evaluated traits, promising lines. NHPJ-2 and NHPJ-1 can be deployed as parents to develop early maturing and high yielding pepper varieties in the south western Nigeria.
***Key words**: Pepper, Genotypes, characterization, fruit length, fruit weight*

INTRODUCTION

Pepper (Capsicum annuum L.) is a member of the solanaceae family and varies in shape, size, colour as well as the degree of hotness/pungency Bozokalfa *et al* 2009. It is the third most important vegetable crop commonly grown in Nigeria after onion and tomato (Uzo, 1984). The fruit is the economic part of the pepper plant and is consumed either fresh or in dried form. The fruits has found great use in nutrition and health Worldwide. It is an excellent source of vitamin A, vitamin B and calcium. It constitutes a vital constituent of the diet of Nigerians as it accounts for 20% of the average daily vegetable in-take either as soups or as condiments (Erinle, 1989). The health benefits of pepper is traceable to the amount of capsaicin (an alkaloid compound found only in pepper) it contains. Capsaicin benefits include anti-carcinogenic (American Association for Cancer Research, 2006. anti-oxidant, anti-mutagenic, immunosuppressive, hypocholesterolaemic, and bacterial growth inhibition effects (Grubben and El Tahir, 2004). Nigeria is the highest producer of pepper in Africa and more than 200 improved and local pepper cultivars (Idowu-Agida *et al*., 2012) are available.

In spite of the overwhelming economic importance of this crop, literature has shown that previous workers concentrated on its agronomy and yield attributes (Aminifard *et al* 2010; Adesina *et al*., 2014; Adeyemi and Ogunsola, 2017; Ndaeyo *et al*., 2017) not much effort has been put into genetic variability in this crop that can lead to varieties. Therefore, this study was undertaken to characterize the existing germplasm for future pepper improvement.

MATERIALS AND METHODS

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The trial was conducted in 2017 wet growing season at the Research Farm of National Horticultural Research Institute, Ibadan (Latitude 7 º 24' 26"N, and longitude 3º50'43"E; 191 meters above sea level. Ibadan has bimodal rainfall distribution, which peaks in June/July followed by a two weeks break in August. This distribution creates two cropping season generally categorized as early and late. The early rains occur between late March/April and end by July while the late rains starts from August/September to November (Olaniyan *et al* 2006). Seeds of mature fruits of the five genotypes were collected from National Horticultural Research Institute (NIHORT) Ibadan, Premier Seed Company and others sourced locally from Eleyele, Ibadan as stated in table 1. The seeds of each Genotype (NHPJ-1, NHPJ -2, NHPJ-3, NHPJ-4 and NHPJ-5) were raised in a nursery trays containing sterilized top soil for 6 weeks in the screen house and watered at two days intervals. Six weeks old pepper seedlings were transplanted to the field when rains were steady.

The experiment was laid out in randomized complete block design with 3 replications in single row plots of 0.5m intra spacing sand 0.7m inter spacing. 250kg ha^{-1} NPK fertilizer was applied at two splits, half at three weeks after seedling establishment and the remaining half applied at the bud initiation stage. Wedding and other cultural practices were carried out as at when due.

Data Collection:

Data were collected on five agronomic traits as follows: Plant height (cm), Days to 50% flowering (DF), fruit color (FC), fruit length (FRL) in cm, and fruit weight (fresh mass in grams) based on the International Plant Genetic Resource Institute (IPGRI, 1998) descriptors for capsicum. The data were subjected to statistical analysis, means were separated using the Least Significant Difference (LSD) and Pearson's correlation matrix was employed to determine the relationship between the agronomic traits.

RESULTS

The means of the evaluated pepper traits is shown in figure 1. NHPJ-2 was the earliest to flower at 22 days after transplanting while NHPJ-4 had the highest number of days to flowering (33 days) after transplanting from the nursery. Genotypes NHPJ-4 AND NHPJ-1 had the highest plant height of 98.3cm and 84.2cm respectively whereas NHPJ-3 had the lowest average plant height of 47cm. (Fig 1). The highest mean fruit length was recorded for NHPJ-4 at 12 (Fig. 1). Highest fruit weight per fruit of 18g was recorded for NHPJ-5 while NHPJ-1 expressed the lowest fruit weight of 6g (Fig. 1). Pepper genotype NHPJ-1 recorded the highest yield per plot (2.8kg) while NHPJ-5 although had the highest fruit weight recorded yield per plot (Fig. 1). Two main Fruit colour were observed in this study for the five pepper genotypes at ripening stage. Except for NHPJ-1 that produced yellow fruits, the other four Genotypes had red fruits at ripening. The relationship between the evaluated traits is shown in Table 2. Yield showed significant negative phenotypic correlation with fruit weight (-0.8295). Plant height showed a significant and positive correlation with fruit length (0.8241**), while days to flowering showed a significant and negative correlation with plant height (-0.6135*).

DISCUSSION

The variation observed among the genotypes based on the considered traits are good indicators that selections can be imposed to

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harness desired traits of interest. The variations observed for days to flowering among the five genotypes evaluated in this study agree with work done by (Sana et al, 2003 and Nkansah *et al*, 2017) who reported that differences in days to 50% flowering might be due to genotype inherited characters and environmental factors. The earliest genotype NHPJ-2 identified in this study can serve as a good progenitor in development of early maturing pepper varieties for the region. The significant variation in plant height among the five genotypes maybe due to their different genetic potentials and ability to absorb and utilize nutrients. This study agrees with work done by (Egharevba and Law-Ogbomo, 2007) who reported significant differences in plant height among different pepper genotypes. Furthermore, it was observed that pepper Genotypes NHPJ-4 which had the highest fruit length per fruit and NHPJ-5 with the highest fruit weight can be deployed to develop new pepper varieties for markets that favour heavy and long pepper fruits. According to Nkansah *et al*, (2017) and Barrera *et al*. (2008), fruits size and weight are used for grading produce with heavier pepper fruits attracting premium price. The high yield recorded for NHPJ-2 may be due to its earliness that gave rise to early fruit maturity and harvesting that might have induced continues flowering and fruit set. This is in agreement with Grubben *et al* (2004) who reported that early harvesting stimulates fruit set. Understanding the relationship between two traits helps the breeder to deploy indirect selection for desired traits in the field. The high negative relationship between yield and fruit weight is an indication that selection in favour of bigger fruits might result in low yield. It was observed from this preliminary study that majority of the genotypes with higher fruit weight also had lower fruit yield per plot compared to the genotypes with low fruit weight. Selection in favour of tall plants in this study might also lead to higher yield due to the moderate but positive phenotypic correlation with yield per plot. Genetic variability is the tool needed to develop new varieties in any crop. In this study, variability existed among the genotypes for various traits. Many workers had used genetic variability among genotypes in various crops to develop early and high yielding varieties (Sana et al; 2011). The early flowering genotypes NHPJ-2 and NHPJ-1 that was high yielding could be employed or cross together to develop early, high yielding cultivar.

CONCLUSION

Appreciable variations were observed among the pepper genotypes for the observed traits. Pepper genotype NHPJ-1 was the earliest to flower, while NHPJ-1 had the highest number of fruits per plant. Selection in favour of heavy fruits might lead to reduced yield among these genotypes. In all, NHPJ-2 and NHPJ-1 might be good parents to cross to create early maturing, high fruiting yellow and red pepper varieties adaptable for South West Nigeria.

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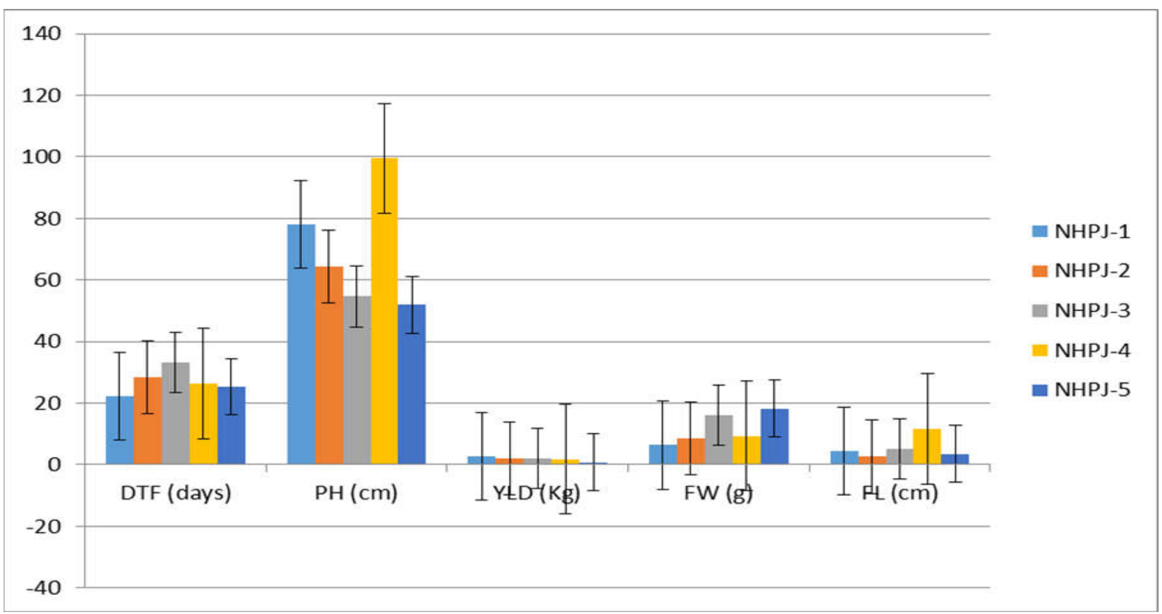
S/N	Source	Code name
1	NIHORT	NHPJ-1
2	Eleyele, Ibadan	NHPJ-2
3	NIHORT	NHPJ-3
4	Eleyele, Ibadan	NHPJ-4
5	Premier Seeds sweet pepper - California wonder	NHPJ-5

Table 1: Sources and code name of genotypes used.



DTF=days to flowering; PH= Plant height at maturity; YLD= Yield per plot; FL= fruit length

Figure 1: Means of evaluated traits among five pepper genotypes

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Table 2. Phenotypic coefficient of correlations between evaluated traits

	DTF	PH	FW	YPP	F L
DTF		-0.6135*	0.9443**	-0.233	0.6156*
PH	-0.6135*		-0.6931*	0.4138	0.8241**
FW	0.9443**	-0.6931*		-0.8295**	-0.1906
YPP	-0.233	0.4138	-0.8295**		0.0206
F L	0.6156*	0.8241**	-0.1906	0.0206	

DTF=days to flowering; PH= Plant height at maturity; YPP= yield per plot; FL= fruit length

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Response of Tomato *(Solanum lycopersicum L.)* to Different Rates of Insecticidal Spray (Cypermethrin 10% E.C) on the Growth and Yield at Bagauda, Bebeji Local Government Area, Kano State

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Abstract
The field experiment was conducted during the 2017 dry season atNational Horticultural Research Institute (NIHORT). Located at Bagauda in Bebeji Local Government Area of Kano State (Latitude 11^0 33^1 N and longitude 8^0 23^1 E with altitude of 481m above sea level) in the Sudan Savannah of Nigeria. The objective of the study was to determine the best rate of insecticide on Tomato production. The treatments comprised of four (4) different rate of (cypermethrin 10% E.C.) on the growth and yield performance of Tomato (Solanum lycopersicum (L.) Kaix) variety (Roma VF). Zero (0) was the control, A and B = single spray, C was double spray, and D was triple spray which were factorially combined and laid out in a Randomized Complete Block Design (RCBD) with three (3) replications. The triple application of cypermethrin in treatment D produced the highest mean value (7.84 tons of fresh fruits) and also it produced the highest growth parameters. While the lowest mean value was obtained from the control or zero spray of (2.04 tons per hectare).
Key Words Tomato, Roma, Transplanting, Cypermethrin and insecticides.

INTRODUCTION

Tomato (*Solanum lycopersicum L.*) belongs to the family Solanaceae, genus *Solanum*, Subfamily Solanoideae and tribe Solanaceae. (Taylor, 1986). The crop is very rich in vitamins, minerals,essential amino acids, sugars and dietary fibres. Tomato contains a high level of lycopene, an antioxidant that reduces risks related to several cancers and neurodegenerative diseases (Srinivasam, et al., 2010). The tomato plant is a native of Central and South America brought to the Mediterranean region by the early explorers. It was first cultivated as a decorative fruits than being edible and it was known then as the love apple (Fayemi, 1999). Tomato is the second most important vegetable after potato. Tomato is grown for its edible fruits which can be eaten raw or processed into salads, cooked, peeled or made into puree, ketchup, soup and powder in canning industries, (Denton and Olufolaji, 2000).

Tindal (1988) reported that temperature above 29^0C tend to inhibit fruiting and night temperatures of 10-20^0C give best yields. J. T. et al., (1984) reported that the period of night temperature over most of the northern parts of the countries of West Africa are 12ºC and 18ºC as the Harmattan winds below between December to early February of the year in Nigeria the most popular varieties are Ibadan local and Bonny best, but the recommended varieties are; Ife I, Havestet, Roma, and Marzanino. Thomas, (2013) reported that there are around 7,500 tomato varieties grown for various purposes. The cultivation of tomato depends on the

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selection of the different characteristics of the fruits which depend on the different growing condition of the area. In Nigeria especially in the North-West region, the type of tomato cultivars usually grownare Roma, UC 82^{B}and Jubaili. (Denton and Olufolaji, 2000).

Insect pests are the most limiting factor in tomato production and hence the use of chemical insecticide spray is the most common method of insect pests control in tomato production. Hussain and Bilal (2007) had reported that insecticidal chemical spray helps to removed infestation of pests on leaves thereby increasing the rate of photosynthesis and promote successful growth of the crops. It is commonly used by farmers to protect their crops against insect pests. However, most farmers due to their illiteracy and lack of exposure coupled with inadequate extension services that could render assistance, do not adhered to the rates strict recommended dosage rates required to protect their crop from the obnoxious insects pest attack and thus cause more harm to themselves and environment. Hence the need to carry out a comparative study for tomato production using three (3) different levels of insecticides spray become necessary in order to highlight and educate the tomato producers on the best recommended rates of insecticides

The study was therefore, carried out to provide a recommended insecticidal rates for controlling insects, pests of tomato during its production. It is hoped the results will be of importance to tomato producers. Interms of adhering to recommendations for optimal input utilization to tomato production and it will be of importance to extension workers for dissemination of the results tolocal farmers.

MATERIALS AND METHODS.

The field experiment was conducted during the 2017 dry season atNational Horticultural Research Institute (NIHORT), located at Bagauda in Bebeji Local Government Area of Kano State (Latitude 11^{0} 33^{1} N and longitude 8^{0} 23^{1} E with altitude of 481m above sea level) in the Sudan Savannah of Nigeria, (Manga et al., 2004).The treatments consist of four different spray methods using *Cypermethrin* as A (control or no spray) single spray B, double spray C and triple spray D. the treatments were laid out in a randomized complete block design (RCBD) and replicated three times. Soil sample of the experimental plots was collected randomly at the depth of 0 - 15cm and 15 – 30cm before conducting the experiment. The soil was analyzed to determine the physico chemical properties.

Tomato variety Roma VF was first cultural practices to ascertain a study growth of the plant was carried out for 5 weeks in the nursery before transplanted. Tomato seedlings were transplanted on beds of 1.5 by 1.5 m with total area 2.23 m^2 containning36 plants. Transplanting ofData collected was on Plant height, number of leaf. Number of branches, leaf area, stand count and yield component. Was done 4 weeks after planting (WAP) at 30 by 30 cm apart, NPK compound fertilizer 15:15:15 was applied two weeks after (WAT) and 6 weeks after transplanting at the rate of 360g/plot using broadcasting methods.

The experimental site was prepared 01/10/2017. Pegs were used during the plot layout establishment. After making out beds were constructed 02/10/2017. Transplanting of seedlings was done on the 04/10/2017. Hoe weeding was carried out at 3 and 6 weeks after transplanting (WAT) to control weeds. Cypermethrin and rodenticides were used to control insects and rodents pests.

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Data collected was on plant height, number of leaf, leaf area, number of branches, stand count and yield components.

Data collected were subjected to analysis of variance (ANOVA)using SAS package (SAS, 2000) described by Snedechor and Cohran (1997) and significance differences between means were separated using (Duncan, 1955) LSD at 5% level of probability.

Treatment with different levels of Cypermethrin 10 % E. C. at the rate of 3 different levels as

- 1st SPRAY 27.8 ml chemical (i.e. Cypermethrin 10 % E.C.) was diluted with 6.7 liters of water and sprayed all over the treatment B, C, and D.
- 2nd SPRAY 18.5 ml of chemical (i.e. Cypermethrin 10 % E.C.) was diluted with 4.5 liters of water and sprayed all over the treatment C. and D.
- 3rd SPRAY 9.3 ml of chemical (i.e. Cypermethrin 10 % E.C.) were diluted with 2.2 liters of water and sprayed all over the treatment D only.

Harvesting was done 4 times at 7 days interval of irrigation. The fruits have matured 4 months after planting i.e. from the date of planting 04/09/2017 to the first harvesting date 27/12/2017

Results and Discussion

Table 1 shows the physico chemical properties of the soil in the study area. The soil was sandy. The organic carbon, total nitrogen and available phosphorus were generally low.

Table 2 and 3 Shows the effect of insecticide spray (Cypermethrin 10 % EC) on plant height and number of leaf respectively at 2, 4, 6, 8, and 10 weeks after transplanting (WAT), the result shows that the more the spray the taller the plant, the more number of leaves and the less the insects attacked. The application of cypermethrin three times gave the higher mean value (34.22) at 2 week, follows the same pattern up to 10 weeks while 0 spray produced the least mean value (20.33) throughout the period. Therefore, the result on plant height shows significant different statistically at both 1% and 5% level of probability at 2, 4, 6, 8, and10 weeks respectively, although from 6 and 8 weeks there was no significant difference.

Table 4 shows the number of branches at 4, 6, 8 and 10 weeks after transplanting (WAT) the result indicated non-significant differences at 4 and 6 weeks at 8 and 10 weeks the means values obtained in 0,1 and 2 spray regime were statistically at par (6.67 and 6.68 respectively). Treatment D produces the highest mean of 6.00 and 8.45 for both 8 and 10 weeks respectively.

Table 6. Shows number of marketable fresh fruits per plot of Tomato at 1st and 2nd harvest. The result indicated significant difference at both harvest. The treatment D produced the highest mean value of 85.68 and 204.04 for the 1st and 2nd harvest respectively. While the least mean value was obtained at control or 0 application. Therefore, this indicated that application of cypermethrin responded to the treatment in which the highest application produced the highest number of marketable fresh fruits.

Conclusion

According to the results obtained, it can be concluded that the use of cypermethrin 10% EC insecticide responded significantly in the growth and yield of Tomato (Solanum lycopersicum) in the study area.

Recommendation

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Base on the results obtained it should be suggested that farmers in the savannah ecological zone should adopt the use of cypermethrin 10 % EC insecticide at three different spray regime for maximum yield in tomato production.

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Table 1. Chemical and physical properties of soil

MECHANICAL ANALYSIS	PERCENT (%)
Sand	71.40
Silt	19.20
Clay	9.40
Total N	0.90
Organic Carbon	0.58
pH	6.10
soil texture	sandy loam

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Table 2. Effect of insecticides spray (Cypermethrin 10% EC) on plant height on the growth and yield of Tomato (Solanum lycopersicumin) for 2016 dry season.

Number of weeks after transplanting					
Treatments	2	4	6	8	10
A	20.33 c	35.78 b	49.6	62.22	119.96 c
B	24.44 bc	39.56 ab	48.0	63.42	124.44 bc
C	29.22 ab	45.82 a	51.8	69.11	130.71 b
D	34.22 a	47.89 a	61.8	69.221	34.92 a
S.E ±	1.11	1.56	5.47	3.24	1.92

Means followed by the same letter (s) are not significantly different at 5 % level of probability using Duncan multiple range test.

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Table 3: Effect of insecticides spray (Cypermethrin 10% EC) on Number of leaves on the growth and yield of Tomato (Solanum lycopersicum) in 2016 dry season.

Number of weeks after transplanting					
Treatments	2	4	6	8	10
A	4.74 d	10.56 b	12.50 ab	12.56 c	19.45 b
B	6.11 c	11.34 b	12.41 b	14.12 c	20.41 b
C	7.97 b	12.56 b	13.71 ab	15.53 b	23.22 b
D	9.89 a	14.77 a	15.74 a	17.33 a	28.00 a
SE ±	0.210	0.400	0.600	0.470	0.820

Means followed by the same letter (s) are not significantly different at 5 % level of probability using Duncan multiple range test.

Table 4: Effect of insecticides spray (Cypermethrin 10% EC) on Number of branches on the growth and yield of Tomato (Solanum lycopersicumin) 2016 dry season.

Number of weeks after transplanting				
Treatments	4	6	8	10
A	2.0	3.34	4.16 c	6.67 b
B	1.55	4.08	5.11 ab	6.78 b
C	1.33	2.78	5.00 ab	6.78 b
D	4.24	4.78	6.00 a	8.45 a
S.E ±	0.550	0.690	0.220	0.230

Means followed by the same letter (s) are not significantly different at 5 % level of probability using Duncan multiple range test.

Table 5. Effect of insecticides spray (Cypermethrin 10% EC) on Total Number of marketable fresh fruits on the growth and yield (tons/ha) of Tomato (Solanum lycopersicum) in 2016 dry season.

	Number of harvest			
Treatments	1	2	3	4
A	0.87 b	4.32 d	18.0 b	78.84
B	1.75 b	4.93 c	36.0 b	96.2
C	1.83 b	5.25	51.84 ab	160.2
D	2.95 a	8.5 a	85.68 a	204.04
SE ±	7.76	23.7	0.180	1.110

Means followed by the same letter (s) are not significantly different at 5 % level of probability using Duncan multiple range test.

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Preliminary Evaluation of Two Okra Hybrids (*Abelmoschus esculentus* (L.) Moench) under Rainfed Conditions in South-Western Nigeria.

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Abstract
Appreciable genetic gains have been made for various traits in many crops using hybrid seeds. However, efforts have remained low in exploiting heterosis to develop and release hybrid okra varieties in Nigeria. The objective of this study was to evaluate the performance of okra hybrids derived from the reciprocal crosses of two inbred breeding lines, IK7 (medium maturing) and Iwo Nla (early maturing) under rainfed conditions. Both hybrids (IK7 x IwoNla and the reciprocal,IwoNla x IK7) and their parents were evaluated in a randomized complete block design with three replicates for number of fruits, days to flowering, number of branches, number of fruits per branch, plant height and number of seeds per pod. The highest number of branches with fruits was recorded for Iwo Nlax IK7, while the inbred line Iwo Nla was the earliest to flower. We anticipate that the high level of heterosis for branching recorded for the hybrid IwoNla x IK7 can be exploited to improve okra yield through increased number of fruits per plant. The implications of potential parent-of-origin effects as observed are discussed.
***Key words**: Heterosis, hybrid, inbred line, reciprocal cross*

INTRODUCTION

Okra (*Abelmoschusesculentus*) originates from Africa and belongs to the Malvaceae family. It is an important vegetable across West Africa (Alimi, 2004). The crop is well adapted to tropical environments and is widely cultivated in most regions across Nigeria because of its importance to the economic development of the rural dwellers and can be found in most markets in the country (Christo and Onuh 2005).

Okra plays a significant role in the nutritional needs of the ever increasing populace via for its fibrous content and other medicinal benefits. The fresh pods serve as soup thickeners due to its mucilage properties and are known to be good sources of vitamins and minerals (Schippers, 2000). Their edible fruit contains86% of water, 2.2% of protein, 10% of carbohydrate, 0.2% of fat and vitamins A, B, and C (Chaudhary, 2003). Despite its production been dominated by poor resourced farmers in Africa and South America the feasibility of fruit export and its prospects as a potential export earner is attracting large producers and seed companiesto invest in okra production (Sawadogo *et al.*, 2006). Several improved varieties, heirloom open pollinated cultivars and hybrids varieties are available for commercial cultivation. Interestingly, despite the higher cost of hybrid seeds compared to other okra varieties, they are gaining more popularity world over due to higher productivity, plant uniformity coupled with appreciable resistance to pests and diseases (Paterniani, 1974; Medagam*et al.*, 2012).

Okra varieties vary by plant height, size of fruit, colour, early or late maturing (Udoh and Akpan, 2005). Despite the important role okraplays in the nutritional and economic life of Nigerian farmers and retailers, not much effort have been directed in the creation of improved varieties to meet the desired preferences of farmers and consumers in Nigeria. This has led to farmers still growing their own low yielding local cultivars or open pollinated varieties that are susceptible to various pest and diseases. Hence this work was carried out to evaluate the performance of reciprocal hybrids with their two parents for selected agronomic traits under field condition.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of National Horticultural Research Institute, Ibadan. The genetic materials evaluated in this study comprised of two inbred parental lines (*IK7*and *Iwo Nla*) obtained from three cycles of selfing and selection from okra germplasm collected from farmers field in south western Nigeria (Anyaoha*et al*., 2018). The two reciprocal hybrids F1 (Iwo Nla x IK7) and F1 (IK7 x Iwo Nla) were developed by the traditional method of emasculation of the female parent followed by manual crosses.Emasculation was done a day prior to the opening of the flower and crossing the following morning according to Nascimento, (2014).Flowers of female parents were emasculated between 5 and6 pm in the evening, whiletransfer of mature pollen from flowers of the male parentto the female parent was carried out between 8 to 10 am in the morning.Fully developed fruits fromthe hybridization were harvested when they reached physiological maturity (evidenced by cracks on the pod ridges of pods) and seeds extracted separately. After extraction, the seeds were dried under shade in pre-labeled brown paper envelops and stored.

Seeds from the twoinbred parental lines and reciprocal hybrids were first treated with an anti-pest dressing (*DressForce*, JubailiAgrotech) prior to planting. Four seeds per hill were planted directly in 3cm holes under field conditions, and later thinned to two plants per hill after seedling establishment. The experiment was laid out in a Randomized Complete Block Design with three replications. Each replicate consisted of two rows of 15 plants for each genotype. Plants were spaced 70 cm x 50 cm between and within rows, respectively. Agronomic maintenance carried out included manual weeding at two and four weeks after planting. NPK 15:15:15 fertilizer was applied in split doses of 60 Kg/ha first at three weeks after planting and later at flowering. Data were recorded from five plants randomly selected from the middle section of each plot on the following agronomic attributes: pedicel length, days to 50% flowering, plant height at maturity, fruit width and length, number of seeds/ fruit, leaf length, pod width followed by number of ridges number of branches and yield.

RESULTS

The ANOVA revealed significant variation for five out of the eleven agronomic traits observed in this studyfor both parents and the reciprocal hybrids (Table 1). No significant variation was recorded for pedicel length, Days to 50% flowering, Plant height at maturity, fruit width and length (Fig. 1).Highest level of variation was recorded for number of seeds/ fruit, leaf length, pod widthfollowed by number of ridges number of branches and yield (Table 1). F1 hybrid (Iwo Nla x IK7) had the highest number of pods, number of branches per plant and number of fruits per fruits per seed with Ik7 recording the smallest leaf length (Table 1). Iwo Nla was the earliest to flower (47 days) while Ik7 had the least plant height of 72 cm(Fig. 1) while the highest leaf width, and fruit length were

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recorded for Iwo Nla and F1 (IK7 x Iwo Nla) respectively (Fig. 2).

DISCUSSION

The main aim of most breeders is to create heterotic hybrids that express superior performance over their parentsfor farmers and consumers preferred traits such as yield, resistance to pest and diseases (Mattedi*et al.*, 2015, Binalfew andAlemu, 2016). Understanding the variation existing for specific traits between parents and their reciprocal hybrids is important in okra hybrid production. True hybrids can be confirmed by using traits that shows significant deviation from those of the mother parents. The results from this study reveal the need to consider the direction of reciprocal in hybrid production. The performance of thereciprocal crosses showed that F1 hybrid created between Iwo Nla x IK7 and vice versa will produce superior when Iwo Nlawas used as the mother parent. This is evidenced by superior performance exhibited by F1 (Iwo Nla x IK7) for number of pods per plant, number of seeds per fruit and number of branches compared to both parents and F1 hybrids (IK7 x Iwo Nla).This is in agreement withMaciel*et al.*(2017) who reported superiority of hybrids for number of fruits per plant over the two parents studied. The reciprocal hybrids showed superiority for most of the traits considered in this study confirming the positive prospect of hybrid okra cultivars for Nigeria farmers. The high number of branching expressed by F1(Iwo Nla x IK7) might have contributed to increased number of fruits recorded for this genotype. The high branching allele might have been contributed by the female parent Iwo Nla since it also expressed higher number of branches compared to IK7. This further confirms the importance of adequate choice of parents for cross breeding since this will go a long way to determine the success and economic returns of okra genetic improvement programme.

CONCLUSION

The overall performance of the two parents and their reciprocal hybrids shows that F1 (Iwo Nla x IK7) had the highest number of pods per plant and number of branches per plant while Iwo Nla was the earliest to flower among the four genotypes evaluated in this study. Heterosis for higher branching might have contributed to increased number of fruits per plant as exhibited by F1 (Iwo Nla x IK7).

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Table 1. Mean of evaluated genotypes for six considered traits

Genotypes	YLD	NSF	NB	LL	FW	NR
Iwo Nla	11	72	1.83	19.5	3.24	5
F1 (Iwo Nla x IK7)	16	106	4.5	20.875	3.42	6
F1 (IK7 x Iwo Nla)	12	104	0	20.75	3.24	6
IK 7	9	80	0	15.875	3.55	7
Prob Level	0.029	<.001	0.002	<.001	<.001	0.001
LSD	3.898	0.8	1.061	0.7956	0.056	0.3

YLD=Yield per plot; NSF=number of seeds per fruit; NB= Number of branches; LL= Leaf length; FW=Fruit width, NR=Number of ridges; LSD= Least significant difference. Probability level= 0.05

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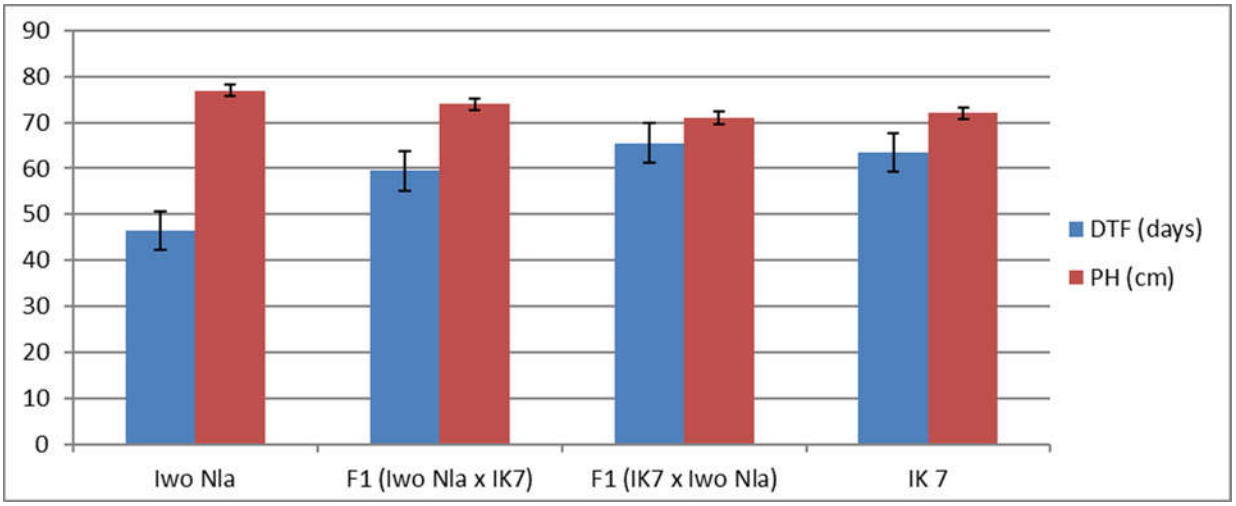

Fig 1. Days to 50% flowering (DTF) and plant height (PH) of the evaluated genotypes

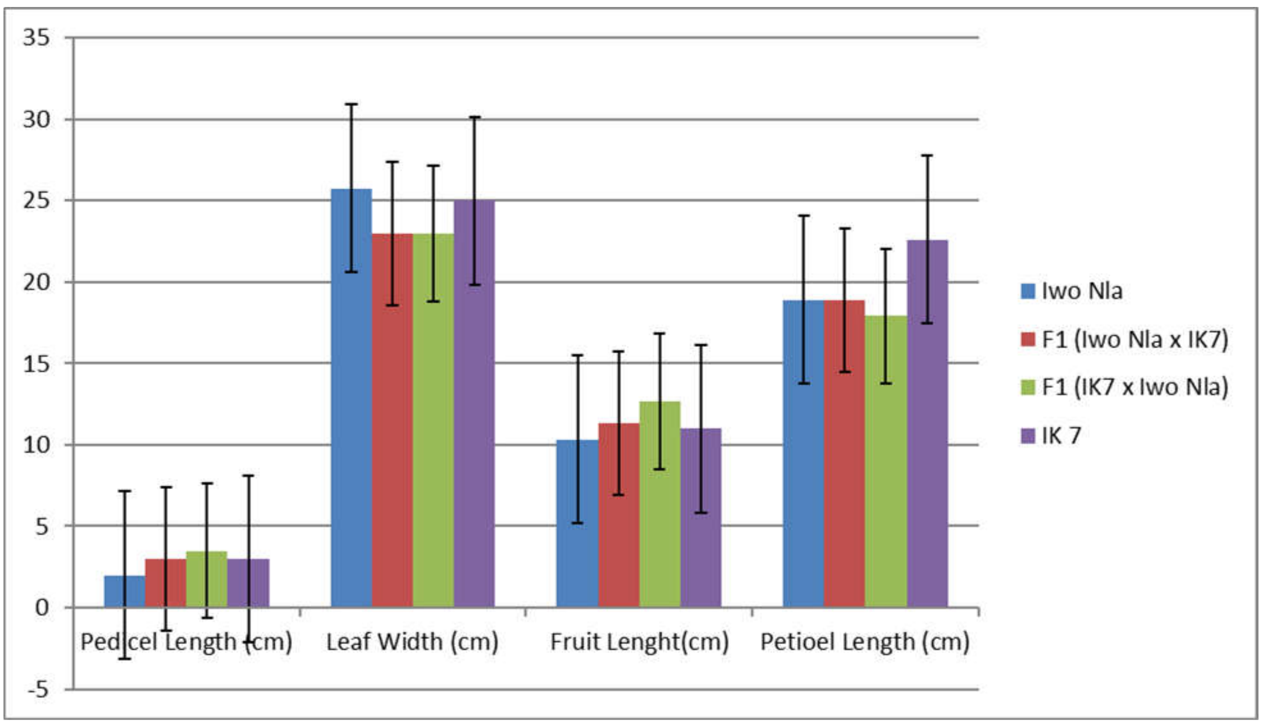

Fig 2. Pedicel Length, leaf width, fruit and petiole length of the evaluated genotypes

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Effects of Single and Mixed Virus Infections on the Germination and Longevity of Some Cultivars of Cowpea

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Abstract
A field trial was carried out to assess the response of twenty five cultivars of cowpea to single and mixed infections with Black eye cowpea mosaic virus (BlCMV) and Cowpea mottle virus (CPMoV) on seed quality. The field trial was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Ahmadu Bello University (ABU), Zaria, Mokwa Station ($09^0$211 N and $5^0$135 E, 201 m above sea level) situated in the Southern Guinea Savannah agro - ecological zone of Nigeria. The seed viability test was determined at the Crop Production Laboratory, Department of Crop Production, Federal University of Technology, Minna, Nigeria. Four independent trials were conducted simultaneously, for single and mixed infections. The field was cleared, ploughed, harrowed and ridged at 0.75 m apart then marked out into plots and replications. The trial was a randomized complete block design (RCBD) replicated three times giving a total land area of 900 m^2. Three cowpea seeds of each cultivar were sown after dressing with Apron – star (methylthiuram + metalaxyl + carboxin) at the of rate 3.0 kg seed per 10 g of the chemical. Seeds were sown at an intra and inter–row spacing of 0.30 × 0.75 m along the ridges and later thinned to two per stand at 2 weeks after sowing (WAS). For the single virus infection, seedlings of the twenty five cultivars were inoculated at 10 days after sowing(DAS) while for the mixed virus infections, seedlings were inoculated at 10 and 17 DAS. The results of the experiment revealed that all cultivars were susceptible to single and mixed infections of the two viruses but to seemingly different extents. The viability of seeds from single infection with CPMoV was slightly reduced in some instances, but, even when seeds viability was not much affected, test of accelerated ageing for four weeks indicated that seed vigour was seriously impaired as compared to the other three virus treatments.

Keywords: *Blackeye cowpea mosaic virus, Cowpea mottle virus, cowpea seeds, Seed quality, Germination*

INTRODUCTION

Cowpea (*Vigna unguiculata* [L.] Walp)is one of the ancient crops known to man. Its origin and domestication occurred in Africa near Ethiopia and subsequently was developed mainly in the farms of the African Savannah (Gómez, 2012). Today, itis widely adapted and grown throughout the world but Africa predominates in production. It is a major staple food crop in sub-Saharan Africa, especially in the dry savanna regions of West Africa (Dugje *et al*., 2009). The seeds are a major source of plant protein and vitamins for man, feed for animals, and also a source of cash income. The young leaves and immature pods are eaten as vegetables (Dugjie *et al*., 2009).It has been estimated that the annual world cowpea crop is grown on 12.5 million hectares, and the total grain production is 3.9 million tonnes (FAO, 2016).More than 8 million hectares of cowpea are grown in West and Central Africa. Also, it is known that Nigeria is the largest producer with 4 million hectaresaccounts for 45 %of the total on 1.15 million hectares annually (Dugjie *et al*., 2009). Other producers are Niger, Mali, Burkina Faso and Senegal (Gómez, 2012). The major cowpea producing areas in Nigeria include Niger, Kwara, Kaduna, Borno, Taraba and Yobe States in the northern part while Oyo, Ogun and Ondo also produce appreciable quantities in the southern part of the country (IITA, 2013).

Virus diseases are considered to be a major limiting factor for the production and productivity of legumes in the tropical and sub-tropical countries (Bashir *et al*., 2000). Out of more than 20 viruses reported on legumes from different parts of the world, (Kareem and Taiwo, 2007) nine are known to infect cowpea naturally in Nigeria. *Blackeye cowpea mosaic virus* was first reported on cowpea in the U.S. in 1955 (Alegbejo, 2015). It is distributed in all ecological zones and cowpea- growing areas of Nigeria. Local symptoms appear as large reddish lesions that spread along the veins, while systemic symptoms appear as severe mottle, mosaic, vein-banding, veinal chlorosis, distortion and stunting of the plant. Disease symptoms vary with virus strain and host cultivar. Incidence varies from 1-40 % on farmers' fields. Yield losses due to the virus vary from 10-85% on individually infected plants and vary with time of sowing. *Cowpea mottle virus* is a positive sense single-stranded RNA, unipartite, isometric virus, 30 nm in diameter (Alegbejo, 2015). The pathogen is distributed in all ecological zones of Nigeria, particularly in the riverine areas of the middle belt which has a Southern Guinea Savanna climate and where a lot of bambara groundnut is grown (Reddy and Devi, 2010). Infected plants display severe mosaic, mottling or bright yellow mosaic. Leaf distortion and reduction in leaf size sometimes leading to a witches' broom appearance in cowpea occurs (Bhat *et al.,* 2011).

Seed-borne viruses are important for source of diseases at the beginning of production even at low rates of seed transmission (Kareem and Taiwo, 2007). In addition, seed-borne viruses can aggravate other transmission methods and cause disease to spread rapidly. Seed-borne and seed transmitted viruses are also damaging to cowpea productivity owing to inherent primary inoculum and potential for their wide dispersal. Information on the possibility of seed transmission in virus infected cowpeas will be valuable to numerous cowpea farmers. Information on germination of infected seeds and survival of resulting plants, virus disease progress during the growing season, magnitude of yield loss and amount of infection in harvested seeds in replicated field experiments is required to establish acceptable threshold levels of seed-borne infections. The study is essential to develop preventive and management measures for cowpea virus diseases in Niger State. Therefore, this research aimed at examining the effects of virus infections on seed quality.

MATERIALS AND METHODS

Field trial

This was conducted during the 2017 wet session at the Teaching and Research farm of the Faculty of Agriculture, Ahmadu Bello University (ABU), Mokwa Station($09^0211'$N and $5^0135'$E, 201 m above sea level) situated in the Southern Guinea Savannah agro - ecological zone of Nigeria. The site used was under continuous cropping between 2012 till the commencement of the study.

Screening site, treatments and experimental design

Four independent trials were conducted simultaneously, for single and mixed infections of the two most common viruses in the study area. In each trial, 25 cowpea cultivars namely Ife Brown, IT90K – 277 – 2, IT96D – 610, IT97K – 499 – 35, IT97K – 568 – 18,IT97K – 573 – 2 –1, IT98K – 205 –M8, IT98KD – 288, IT99K – 316 – 2, IT99K – 377 – 1, IT00K – 901 – 5, IT03K – 337 – 6, IT04K – 267 – 8, IT04K – 291 – 2, IT04K – 321 – 2, IT04K – 332 – 1, IT06K –

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124, IT06K – 137 – 1, IT07K – 211 – 1 – 8, IT07K – 222 – 2, IT07K – 243 – 1 – 10, IT07K – 251 – 3 – 3, IT07K – 292 – 1 – 10, IT07K – 299 – 6 and IT07K – 318 – 33) constituted the treatments. The cultivars were photosensitive and high yielding under virus free conditions. The field was cleared, ploughed, harrowed and ridged with tractor at 0.75 m apart then marked out into plots and replications. Each cultivar was evaluated in 0.375 m ridge wide, 3 m long and 0.75 m apart giving a total plot size of 18.75 m per replicate. The trial was arranged as randomized complete block design (RCBD) replicated three times giving a total land area of 900 m^2.

Source of inoculum and multiplication

The *Blackeye cowpea mosaic virus* (BICMV)and *Cowpea mottle virus* (CPMoV) isolates used were obtained from the Department of Crop Production, Federal University of Technology, Minna Niger State. The virus isolates were extracted by grinding 1g/ml of each isolatein extraction buffer containing 0.1M sodium phosphate dibasic, 0.1M potassium phosphate monobasic, 0.0lM ethylene diamine tetra acetic acid and 0.00lM-cystine per litre of distilled water using a pre-cooled sterilized mortar and pestle as described by Kumar (2009). Two microlitres of β- mercapto-ethanol was added to the extract just before use. Thereafter, cowpea seedlings were infected with BICMV and CPMoV inoculum at 10 days after sowing (DAS) by rubbing the virus extracts on the upper surface of the leaves that was dusted with carborundum powder (600- mesh). The leaves of inoculated plant were rinsed with sterile distilled water. Symptomatic cowpea leaves were collected from the infected plants at 3 weeks after inoculation (WAI) and used for inoculation during the main experiment. The leaves were preserved at room temperature in airtight via bottle on silica gels covered with a thin layer of non-absorbent cotton wool.

Agronomic practices

The study site was manually cleared of the previous plant remains and ridged in the second week of August, 2017. Cowpea seeds were sown one week after the land preparation. Three cowpea seeds of each cultivar were sown after dressing with Apron – star (methylthiuram + metalaxyl + carboxin) at the of rate 3.0 kg seed per 10 g sachet of the chemical to protect seed against soil borne pathogens. The sowing was carried out at an intra and inter–rowspacing of 0.30 × 0.75 m along the ridges and later thinned to two per stand at 2 weeks after sowing (WAS). The BICMV and CPMoV infected cowpea leaves previously preserved on silica gels were used for inoculation. For the single virus infection, seedlings of the twenty five cultivars were mechanically inoculated singly with BICMV or CPMoV at 10 days after sowing while for the mixed virus infections, seedlings were inoculated at 10 and 17 DAS. Weeds were manually controlled through hand weeding at 4 and 6 weeks after sowing. Insect pests were controlled by spraying D-D force (Cypermethrin plus Dimethoate) and pods were harvested at physiological maturity. The pods were processed and packaged for seed quality y assessment in the laboratory.

Assessment of Virus Infection on Seed Quality

Seed lots from the various virus treatments were subjected to seed quality test as follows;

Germination and longevity of seeds of all the virus treatment combinations were determined by germination test after harvest and at four weeks of storage respectively at the Crop Production Laboratory,

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Department of Crop Production, Federal University of Technology, Minna. There were 25 seeds placed in distilled-water moistened filter paper lined in Petri-dish in three replicates. The filter paper in the petri-dishes were kept moist as found necessary. The petri-dishes were arranged inside the seed germination chamber. Germination counts were taken at 1, 2, 3, 4 and 5 days after sowing. Seeds were considered germinated when the tip of the radicle had grown free from the seed coat (El Balla *et al*., 2011). Germination percentage (GPCT) was calculated as follows:

GPCT= Total number of seedlings that emerged on the final day × 100
Total number of seeds planted

Cowpea seeds were also subjected to accelerated ageing tests at two and four weeks as described by El Balla *et al*. (2011) for vigour determination. The seeds of all the treatments were stored in open plastic plates and arranged inside an incubator at 35 ^{0}C and 86 % relative humidity. This was aimed at accelerating the ageing of the seeds so that the relative longevity of the seed samples could be determined. Twenty five seeds from each treatment that were artificially aged in three replications were counted and placed on layer of distilled water moistened-filter paper placed in Petri-dishes over a wire mesh screen inside a growth chamber at 30 ^{0}C. Germination count was taken as described above.

Data analysis

Data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS, 2008) to verify if there were significant differences among the cultivars. Significance was determined at 5 % level of probability. Where the *F*-test ratio was significant, means were separated using Student-Newman-Keuls (SNK) test.

RESULTS

Effects of single and mixed virus infections on seed quality

The study revealed significant impairments in germination before and after four weeks of storage of the 25 cultivars of cowpea both in single and mixed infections of the viruses used. The variation in seed germination of cowpea cultivars with respect to virus infections is presented in Table 1. Prior to storage of seeds, the difference between the lowest and highest mean value for seed germination was wide and significant (p<0.05). Seed germination percentage varied from 77.4 to 99.7 % for the BICMV infected cultivars, 77.4 to 98.7 % for CPMoV infected cultivars, 74.8 to 98.5 % for BICMV + CPMoV infected cultivars and 78.6 to 98.5 % for CPMoV + BICMV inoculated cultivars (Table 1).Seeds obtained from IT97K-568-18, IT04K-332-1 and IT07K-292-1-10 cowpea cultivars infected with BICMV had significantly (p<0.05) higher germination percentage of 99.7 which was statistically similar to 97.6 and 97.3 % germination obtained from seeds of cultivar IT07K-243-1-10 and IT03K-337-6respectively. Seeds from cultivars IT90K-277-2, IT07K-211-1-8 and IT06K-124 had germination values of 94.7, 94.3 and 93.7 % respectively which were not significantly different among each other. Seeds of cultivars IT07K-251-3-3 and IT07K-222-2 had 92.3 and 92.5 % germination values respectively which were statistically similar while seeds from the remaining cowpea cultivars had germination percentages ranging between 77.4 and 91.3.

Furthermore, seed germ in ability of 98.7 % was highest in IT90K-277-2 with CPMoV infected cowpea seeds which was not significantly ($p > 0.05$) different from seeds obtained from cultivars IT04K-332-1 (98.5

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%), IT07K-243-1-10 (98.4 %), IT04K-267-8 (98.2 %) and IT96D-610 (97.7 %), while significantly lowest seed germination percentage of 77.4 was recorded in seeds of cowpea cultivar IT07K-292-1-10 (Table 1). On the other hand, co-infections of cowpea seeds significantly (p<0.05) affected seed germ in ability across the cowpea cultivars investigated. BICMV + CPMoV infected IT04K-332-1 exhibited the highest germination percentage of 98.5 % than all other cultivars, whereas IT96D-610 and IT97K-499-35 gave 97.6 % each. Seeds of cultivars IT07K-292-1-10 and IT97K-573-2-1 had 96.0 and 94.8 % germination respectively, while seeds of cultivar IT07K-222-2 gave in the lowest germination percentage of 74.8. Seeds obtained from cultivar IT97K-568-18 infected with CPMoV + BICMV exhibited the highest germination percentage of 98.5 before storage which was not significantly (p> 0.05) different from 97.3 % obtained from seeds of IT99K-316-2. Next to these with high germination percentage of 96 were seeds obtained from IT90K-277-2, IT96D-610, IT98K-205-M8, IT98KD-288, IT04K-332-1 and IT07K-222-2 whereas the significantly lowest germination percentage of 78.6 was recorded in seeds of cowpea cultivars IT04K-321-2 and IT07K-211-1-8. (Table 1).

Similarly, the difference between the lowest and highest percentage mean values for the longevity test was also wide and significant (p<0.05) when seeds were stored for four weeks. Significantly highest germination percentage of 77.9 was recorded in seeds of BICMV infected Ife Brown followed by IT90K-277-2, IT00K-901-5 and IT96D-610 with 76.6, 70.6 and 70.3 germination percentage, respectively. Seeds of cultivar IT97K-568-18, IT07K-292-1-10 and IT07K-299-6 exhibited germination values of 69.5, 64.4 and 62.1 %, respectively whereas the least germination values of 46.6 % was obtained from seeds of IT06K-124. Mean value for accelerated ageing germination (AAG) on CPMoV infected cowpea cultivars showed that seeds of IT98K-205-M8 had 70.6 % germination. This was closely followed by seeds of Ife Brown with 69 % while 68, 66.8 and 66.5 % were obtained from cultivars IT90K-277-2, IT03K-337-6 and IT96D-610, respectively. The germination capacity of 64 % was recorded from seeds of cultivars IT99K-316-2 while IT07K-299-6 and the remaining cultivars had AAG percentages ranging from 53.4 to 62.7 % (Table 1).

For the mixed infection treatments, germination value of 58.6 % was obtained from IT90K-277-2, IT06k-124 and IT07K-292-1-10 BICMV + CPMoV infected cowpea cultivars. This value (58.6 %) was significantly (p<0.05) higher than the values obtained from seeds of other cultivars. Seeds from cultivars IT98K-205-M8, IT97K-499-35, IT06K-137-1 and IT07K-211-1-8 gave germination values of 56.5, 55, 54.5 and 53.4 % respectively. Seeds of cultivars IT96D-610 and IT00K-901-5 exhibited similar germination percentage of 52 while the remaining cowpea cultivars had germination percentages of between 44.0 and 50.6. Also, seed germ in ability of 57.3 % was highest in IT07K-292-1-10 with CPMoV + BICMV infected cowpea seeds which was statistically (p>0.05) similar to the performance of seeds of IT97K-499-35 with 56 %. Seeds of cultivar IT04K-267-8 and IT07K-222-2 exhibited 54.6 and 53.7 % respectively, while IT96D-610 and IT04K-291-2 had germination values of 52 % which did not differ from one another. The lowest AAG percentage of 31.6 was

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recorded in seeds of cowpea cultivar IT99K-377-1 (Table 1).

DISCUSSION

Germination and longevity are two major indices used for determining the performance capability of seed lot. Seed quality is influenced by the environment where it is produced. Pathogens namely virus, nematode, fungi, bacteria among others are integral components of the environment of any seed crop; failure to effectively manage their competition could mean zero harvest (Adesina *et al*., 2012) as found in this study. However the imperative of understanding the impact of virus management strategies and management for quality seed production arises from the paucity of information on the agronomy of seed production (Adesina *et al*., 2012), more so that seed production efforts are judged on the basis of quality of the produce rather than quantity. The result of this study has established a clear negative influence of virus infection on cowpea seed quality and that the differential ranking of the virus infection treatments in different seed quality test is an indication of the response of the developing seeds on the mother plant to competing virus infection situations. Differences in time of flower initiation, pod setting, seed formation and maturity to virus infections are critical factor to tropical farming. The results obtained from this study revealed that there was a variation in germination percentage before and after four weeks of storage which is a measure of seed viability and longevity. When seed that has this trait is sown on the field for production, it exhibits a wide variation in performance after sowing due to the differences in quality (Adesina *et al*., 2012). Since seeds did not ripen at the same time amongst virus treatments across the test cowpea cultivars, variation in seed germination and longevity due to age at harvest is inevitable (Singh, 2014).

It is known that cowpea seedlings are susceptible to virus infection at different stages of development (Agrios, 2005). This is supported by the differential responses of cowpea seeds harvested from the different virus treatment seed lots in the present study. The initial general high germination percentage recorded in seeds of all treatment combinations in this study is an indication that the seeds did not exhibit dormancy contrary to what is known with most vegetable seeds when freshly harvested. This rapid germination also showed that the activities of the pathogens (viruses) on the seeds were not severe enough to impaired germination (Anjorin and Mohammed, 2014). Mandhare and Gawade (2010) reported that thoughseeds obtained from mosaic infected bean at harvest exhibited high seed germination, a significant sharp decline in germination percentage of the seeds was recorded following four weeks of storage at 32 ^{0}C and 50 % relative humidity.

Following storage of seeds for four weeks in this study, a sharp decline in the germination capability of seeds of all the treatment combinations was recorded. This sharp decline in the quality of seeds is abnormal according to the normal/natural seed ageing process (Hamim *et al*., 2014). The reason may be that the pathogen activities must have been activated which resulted in the sudden and heavy decline in the germination percentages (Ahmad *et al.,* 2006). Furthermore, the variation in germination percentages amongst the cultivars and treatments as shown in this study suggest genetic superiority (Anjorin and Mohammed, 2014) and tolerance level of the cultivars over one another.

CONCLUSION AND RECOMMENDATIONS

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The results of the experiment revealed that all cultivars were susceptible to single and mixed infections of the two viruses but to seemingly different extent. The germination of seeds as seen from this study was generally high before storage; the high initial germination percentage was not sustained (short lived); an indication that conservation of infected seeds of all cultivars was impaired. More so, all the cowpea cultivars did not exhibit dormancy which is a problem with most freshly harvested vegetable seeds. The bene ts of increased cowpea production include improved nutrition for humans and livestock, improved soil properties and substantial opportunities for greater income. The monitoring and management of these viruses therefore is crucial to sustainable cowpea production most especially in sub-Saharan Africa. There is the need, therefore, for constant monitoring of legume fields through regular field sanitation, disease surveys to identify new and emerging viruses because these facts present a good starting point for legume virus diseases diagnosis in the study area. Finally, there is also need to ensure availability of acceptable horticultural desirable cowpea cultivars with a high level of resistance to cowpea viruses for the nation to sustain its high level of production.

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Table 1: Cowpea seed quality as affected by single and mixed infections of *Blackeye cowpea mosaic virus* (BICMV) and *Cowpea mottle virus* (CPMoV) at Mokwa in 2017

	Germination Test (%)				Accelerated Ageing Germination (%) 4 Weeks of Storage			
Cultivar	BICMV	CPMoV	BI + CP	CP + BI	BICMV	CPMoV	BI + CP	CP + BI
Ife Brown	93.5^{bcd}	90.5^{c-f}	86.7^{f}	86.5^{gh}	77.9^{a}	69.0^{b}	56.6^{b}	46.2^{l}
IT90K – 277 – 2	94.7^{bc}	98.7^{a}	78.5^{c}	96.0^{bc}	76.6^{a}	68.0^{bc}	58.4^{a}	51.6^{e}
IT96D – 610	87.3^{g}	97.7^{a}	97.6^{b}	96.0^{bc}	70.3^{b}	66.5^{d}	52.0^{e}	52.0^{de}
IT97K – 499 – 35	88.0^{fg}	86.9^{i}	97.6^{b}	92.0^{e}	61.5^{de}	60.0^{g}	55.0^{c}	56.0^{ab}
IT97K – 568 – 18	99.7^{a}	91.2^{c}	81.3^{j}	98.5^{a}	69.5^{b}	57.2^{h}	48.0^{h}	41.2^{l}
IT97K – 573 – 2 – 1	87.8^{g}	93.4^{b}	94.8^{d}	94.5^{d}	50.6^{l}	57.1^{hi}	45.5^{i}	35.6^{m}
IT98K – 205 –M8	87.6^{g}	89.2^{efg}	77.5^{m}	96.0^{bc}	57.5^{gh}	70.6^{a}	56.3^{b}	41.5^{l}
IT98KD – 288	91.3^{c-g}	90.7^{cde}	82.6^{i}	96.0^{bc}	48.0^{m}	62.7^{f}	48.3^{gh}	51.3^{ef}
IT99K – 316 – 2	92.1^{c-f}	93.4^{b}	85.0^{gh}	97.3^{ab}	53.3^{jk}	$64.0e^{f}$	57.3^{ab}	46.0^{j}
IT99K – 377 – 1	88.9^{efg}	90.8^{cd}	85.4^{gh}	92.0^{e}	60.0ef	60.0^{g}	50.6^{f}	31.6^{n}
IT00K – 901 – 5	88.8^{efg}	86.1^{i}	81.3^{j}	89.3^{f}	70.6^{b}	65.0^{e}	52.0^{e}	47.0^{ij}
IT03K – 337 – 6	97.3^{ab}	89.4^{d-g}	84.6^{h}	89.3^{f}	50.5^{l}	66.8^{cd}	46.4^{i}	41.4^{l}
IT04K – 267 – 8	92.2^{c-f}	98.2^{a}	81.3^{j}	86.5^{gh}	56.0^{hi}	62.6^{f}	49.5^{fg}	54.6^{bc}
IT04K – 291 – 2	87.8^{g}	86.9^{i}	89.3^{e}	87.7^{g}	54.6^{ij}	58.7^{g}	57.4^{ab}	52.0^{de}
IT04K – 321 – 2	90.5^{c-g}	93.8^{b}	85.3^{gh}	78.6^{k}	58.6^{fg}	56.3^{hi}	48.0^{h}	50.6^{efg}
IT04K – 332 – 1	99.7^{a}	98.5^{a}	98.5^{a}	96.0^{bc}	60.0^{ef}	53.4^{k}	49.3^{fgh}	48.1^{hi}
IT06K – 124	93.7^{bc}	90.1^{c-g}	80.0^{k}	81.2^{j}	46.6^{m}	56.8^{hi}	58.6^{a}	49.6^{fgh}
IT06K – 137 – 1	77.4^{h}	87.2^{hi}	78.8^{l}	80.0^{jk}	52.0^{kl}	56.0^{hij}	54.5^{cde}	44.0^{k}
IT07K – 211 – 1 – 8	94.5^{bc}	88.5^{gh}	89.3^{e}	78.6^{k}	53.3^{jk}	56.0^{hij}	53.4^{d}	49.3^{gh}
IT07K – 222 – 2	92.5^{cde}	93.0^{b}	74.8^{n}	96.0^{bc}	54.2^{j}	56.4^{jk}	45.3^{ij}	53.7^{bc}
IT07K – 243 – 1 – 10	97.6^{ab}	98.4^{a}	89.3^{e}	94.8^{cd}	57.5^{gh}	54.7^{jk}	50.5^{f}	50.8^{efg}
IT07K – 251 – 3 – 3	92.3^{cde}	88.5^{gh}	82.8^{i}	85.3^{h}	57.3^{gh}	56.6^{ij}	44.0^{k}	47.0^{ij}
IT07K – 292 – 1 – 10	99.7^{a}	77.4^{j}	96.0^{c}	81.3^{j}	62.1^{d}	57.3^{h}	58.3^{a}	57.3^{a}
IT07K – 299 – 6	80.3^{h}	89.0^{gh}	86.8^{f}	82.6^{i}	64.4^{c}	64.0^{ef}	49.7^{f}	44.0^{k}
IT07K – 318 – 33	89.3^{d-g}	77.6^{j}	85.6^{g}	80.0^{jk}	59.8^{f}	58.7^{g}	44.9^{jk}	46.5^{ij}
SE ±	1.27	0.5	0.26	0.43	0.54	0.46	0.42	0.61

Means with the letter (s) within the same column are not significantly ($p \leq 0.05$) different by Student-Newman-Keuls (SNK) test

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Field Screening of Five Varieties of Eggplant, *Solanum* spp. for Susceptibility to Eggplant Shoot and Fruit Borer, *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) Infestation in Okigwe, Southeastern Nigeria

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Abstract
Five varieties of eggplant; Solanum aethiopicum, Solanum ex-lantan, Solanum gilo, Solanum macrocarpon and Solanum melogena were screened for their susceptibility to Eggplant Shoot and Fruit Borer (EFSB), Leucinodes orbonalis Guenee infestation between May – September 2017. The treatments were arranged in Randomized Complete Block Design (RCBD) with four replications. Each experimental unit measured 9 m^2 with 16 plant stands respectively. Data on adult moth population, larval infestation, length of larval feeding tunnel, number of holes on fruits and shoots were collected from four tagged plants in the middle rows. Results of Analysis of Variance (ANOVA) revealed that the least population of adult moths of L. orbonalis, 0.79 was recorded in May, however, there was a steady increase in adult moths as the months progressed, which peaked in September with 16.15 ESFB adult moths population. This represents 41.98% of the total larval infestation across the months. S. gilo had the highest percentage larval infestation of 32.10%, while the least larval infestation, 9.59% was recorded with S. melogena. Length of feeding tunnel ranged from 0.60±0.01 – 2.76±0.20 cm, with S. gilo recording the longest feeding tunnel of 2.76 cm. Number of holes on fruits and shoots were highest with S. gilo, 2.56±0.05 holes per fruit per plant and 2.75±0.20 holes per shoot per plant. Significant differences ($P<0.05$) existed amongst the varieties screened on percentage infested and uninfested fruits with S. gilo recording significantly ($P<0.05$) higher percentage infested fruits of 70.68% and least, 29.32% of uninfested fruits. Varieties screened did not show significant differences ($P>0.05$) on damaged yield but exhibited significant differences ($P<0.05$) on marketable yield; S. melogena recording the highest (1.32±1.30 tha^{-1}) and S. gilo, the least with 0.53±1.50 tha^{-1}. The screening revealed that the varieties exhibited varying levels of susceptibility to ESFB infestation with S. gilo the most susceptible, followed by S. aethiopicum, S. ex-lantan, S. macrocarpon and S. melogena in that order, respectively.
Keywords: *Eggplant, ESFB, Leucinodes orbonalis, infestation, screening*

INTRODUCTION

Eggplants contain flavonoids, such as anthocyanins. Anthocyanins are water-soluble pigments that have many health benefits (Megan, 2017). The skin of the eggplant is rich in antioxidants, fiber, potassium, and magnesium. The phenolic content of eggplant makes it such a potent free radical scavenger that this vegetable is ranked among the top 10 vegetables in terms of oxygen radical absorbance capacity. The fiber, potassium, vitamin C, vitamin B6, and phytonutrient content in eggplants all support heart health. In addition, eating foods containing certain flavonoids, including anthocyanins, may be associated with a lower risk of mortality from heart disease, according to a Hooper *et al.* (2008).

In one study, those who consumed more than three servings of fruits and vegetables per week containing anthocyanins had a 34-percent lower risk of heart disease than those who consumed less (Jennings *et al.*,

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2012). In another, an increased intake of anthocyanins was associated with significantly lower blood pressure (Cassidy *et al.,* 2013). Research has shown that when rabbits with high cholesterol consumed eggplant juice, this led to significantly lower weight and blood cholesterol levels (Tempest, 2012). Chlorogenic acid contained in eggplants has been shown to decrease low-density lipid (LDL) levels. It also acts as an antimicrobial, antiviral, and anticarcinogenic agent (Jorge *et al.,* 2008).

Polyphenols in eggplant have been shown to have anti-cancer effects (Stommel and Whitaker, 2003). Anthocyanins and chlorogenic acid protect cells from damage caused by free radicals and, in turn, prevent tumor growth and the invasion and spread of cancer cells (Wang and Stoner, 2008). The anticancer action of anthocyanins appears to include preventing new blood vessels from forming in the tumor, reducing inflammation, and blocking the enzymes that help cancer cells to spread.

Findings from animal studies suggest that nasunin, an anthocyanin in the eggplant skin, is a powerful antioxidant that protects brain cell membranes from free radical damage (Nado *et al.,* 2000). It also assists in the transport of nutrients into the cell and moving waste out. Research has also shown that anthocyanins help prevent neuro inflammation and facilitate blood flow to the brain. This could help improve memory and prevent age-related mental disorders. Dietary fibers are commonly recognized as important factors in weight management and loss, because they act as "bulking agents" in the digestive system. These compounds increase satiety and reduce appetite. They help reduce calorie intake by making a person feel fuller for longer. Eggplant is already low in calories, so it can contribute to a healthful, low-calorie diet. Research has suggested that the antioxidants in eggplant may help protect the liver from certain toxins.

Leucinodes orbonalis, the eggplant shoot and fruit borer or brinjal fruit and shoot borer, is a moth species in the genus *Leucinodes*. It is found throughout the tropics in Asia and Africa and is a minor pest in the Americas. The species was first described by Achille Guenée in 1854 (https://en.wikipedia.org/wiki/Leucinodes_orbonalis). Larvae bore inside eggplant fruits and feed until they pupate. Fruit feeding by *L. orbonalis* larvae is the major cause of damage, leaving frass as it tunnels through the fruit, thereby rendering the fruits unfit for consumption (Emeasor and Uwalaka, 2018). The larvae also bore into tender shoots causing wilting and dieback of the branch terminals. This reduces the fruit-bearing capacity of the plant (Emeasor and Uwalaka, 2018).

This insect pest has been categorized in 2014 as a major pest of eggplant in Nigeria having been found to be widely distributed and infesting the plants throughout the country (CIE, 1976; EPPO, 2014). Its infestation on eggplants has been reported to have resulted in over 75 – 90 % reduction in fruit yield of eggplants in Nigeria (Onekutu, 2011). These reports informed our resolve to carry out this study, to screen five varieties of eggplant in this region for their susceptibility to Eggplant shoot and Fruit Borer, *Leucinodes orbonalis* Guen. The outcome of this study would give an insight on the most susceptible varieties; hence the control and management of the pest in future studies.

MATERIALS AND METHODS

The study was conducted in 2017 cropping season at the Vegetable Research Farm of National Horticultural Research Institute (NIHORT) Mbato Outstation, Okigwe, Southeastern Nigeria. The institute lies on latitude 05° 33´ N and longitude 07° 23´ E with an altitude of 130 m above sea level.

Seeds of *Solanum aethiopicum, Solanum ex-lantan, Solanum gilo, Solanum macrocarpon* and *Solanum melogena* were raised in the nursery following standard agronomic practices and transplanted to the experimental plots which measured 9 m^2 each. The five varieties of eggplant were used as the experimental treatments and were laid out in Randomized Complete Block Design (RCBD) with four replications.

Assessment of susceptibility of *Solanum* varieties to the Eggplant Shoot and Fruit Borer was done on four selected tagged plants from the middle row of the plots on a fortnight basis. Data was also collected on number of holes on shoot and fruit by visual observation and counting, population of *L. orbonalis* larvae by cutting open sampled fruits to check for their presence, length of feeding tunnel by using measuring tape, fruit length and fruit diameter was determined with vernier caliper, number of fruits by counting, damage and marketable yields were determined using a weighing balance. Percent infested and uninfested fruits were also determined. Analysis of variance was conducted on all means of the parameters assessed and significant means were compared using Least Significant Difference (LSD) at significance level of 5%.

RESULTS AND DISCUSSION

Field observations showed that *L. orbonalis* infested all the eggplant varieties screened throughout the period of this study (Tables 1, 2 and 3). Farman *et al.* (2016) and Purohit and Khatri, (1973) had reported that all stages of eggplant are attacked by *L. orbonalis* as the insect is regarded as one of its major insect pests.

Suresh *et al.* (1996) and Singh *et al.* (2000) in their separate studies on *L. orbonalis* destructive activities on eggplants reported that the insect pest is the most destructive insect pest of eggplant at various physiological growth of the plant. EPPO (2015) had declared *L. orbonalis* infestation as having attained the category of a severe pest for eggplants.

During the early stages of vegetative growth of the eggplants, there was a minimal population of *L. orbonalis* adult moth especially in the months of May and June, but in later months of July, August and September, from the data collected and analyzed, the results showed that there was a consistent build up in the number of adult moth of *L. orbonalis* found on the plants (Tables 1 and 2). This finding is in line with the reports of Farman *et al.* (2016) who recorded an initial 18.68% infestation of *L. orbonalis* in the month of May and observed a higher infestation rate of up to 75.50% from the month of August in India. Obodji *et al.* (2015) also reported that *L. orbonalis* infestations increased progressively from early growth stage to fruiting stage in the South of Ivory Coast. Monitoring of the population trend and seasonal abundance of *L. orbonalis* in this present study revealed that the peak infestation of 41.98% occurred in the month of September (Table 2). This finding is also in agreement with the account of Farman *et al.* (2016) who recorded percent infestation of 42.64% during the last picking in September.

In terms of varietal infestation, *S. gilo* was the most infested eggplant variety with 32.10% infestation level (Table 3). This

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finding corroborates the earlier findings of Uwalaka *et al.* (2012) and Emeasor *et al.* (2016) whose reports found that *S. gilo* as the most attacked eggplant variety by *L. orbonalis* in Southeastern Nigeria as the variety is also considered to be indigenous to the region and locally known as Ngwa large (Emeasor *et al.,* 2016).

There was more damage in terms of numbers of hole per shoots and fruits on *S. gilo* than in other varieties of eggplant screened (Table 5). The eggplant variety, *S. gilo* had significantly (P<0.05) more holes on shoots and fruits compared to other four varieties, these findings may however explain for the longest feeding tunnel of 2.76±0.20 cm recorded in *S. gilo* (Table 5). This result differed significantly (P<0.05) when compared with mean length of feeding tunnel obtained from *S. melogena* (0.60±0.01 cm), *S. aethiopicum* (1.53±0.09 cm), *S. ex-lantan* (1.38±1.00 cm) and *S. macrocarpon* (1.32±0.05 cm) (Table 5). Sudarshan and Pijush (2011) also reported similar results. One interesting observation in this study is that all the eggplant varieties screened showed no absolute immunity or resistance to the infestation by *L. orbonalis*, although they exhibited varying levels of susceptibility to the insect pest with *S. gilo* and *S. aethiopicum* having very high susceptibility. Emeasor and Uwalaka (2018) reported that eggplants are susceptible to *L. orbonalis* infestation. Their report validates the findings of this present study.

This study on the screening of five varieties of eggplant for their susceptibility to *L. orbonalis* showed that percent fruit infested and uninfested fruits varied according to varieties (Table 6). The highest percent infested fruits of 70.68% were obtained in plots planted *S. gilo,* followed by 67.88% infested fruits recorded for *S. aethiopicum* while the lowest percent infested fruits of 50.44% was achieved by *S. melogena* (Table 6). Results of analysis of variance showed that *L. orbonalis* significantly (P<0.05) infested the fruits of eggplant varieties screened. Similar results were reported by Obodji *et al.* (2015) who recorded 56.67% and 77.61% fruit infestation at 159 and 166 days after transplanting (DAT) with Djamba F_1 eggplant variety.

There was no varietal differences (P>0.05) on percent uninfested fruits (Table 6). *L. orbonalis* larval infestation affected and reduced significantly the production of uninfested fruits irrespective of variety. All the varieties screened recorded below 50% of wholesome (uninfested) fruits (Table 6). This reduction in percent uninfested fruits recorded by the eggplant varieties could be justified by the fact that the plants fruits were available for *L. orbonalis* larvae to feed on and provided a favourable abode for them to thrive which may also account for their high infestation level since no insecticidal treatment was applied for their control. Similar observations were made by Oboji *et al.* (2015) and Shukla and Khatri (2010) who also mentioned that the highest infestations were recorded at the beginning of fruiting when uncontrolled. Haseeb *et al.* (2009) and Saeed and Khan, (1997) also reported fruit losses of between 20 – 60%.

Analysis of variance revealed that there was no varietal differences on damage yield as influenced by *L. orbonalis* (Table 6). Generally, all the five varieties recorded low marketable yield largely due to the devastating activities of *L. orbonalis* larvae. Results also revealed that *L. orbonalis* significantly (P<0.05) affected the marketable yield of the eggplants. The lowest marketable yield of 0.53±1.50 t/ha

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was recorded on *S. gilo* and *S. aethiopicum* each respectively (Table 6).

Observations of some morphological characters of the eggplant varieties such as fruit diameter, fruit length and shoot girth were also assayed. Significant differences (P<0.05) existed between the varieties on these morphological parameters assessed. *S. melogena* has distinctive longer fruit length of up to 19.76±0.68 cm and the highest mean value of 2.48±0.37 cm for shoot girth. *S. macrocarpon* had the highest value (5.04±0.40 cm) for fruit diameter, followed by *S. gilo* with 4.86±0.58 cm (Table 4).

On number of fruits, *S. aethiopicum* produced the highest with 128.50±1.20 fruits per plant per plot. The study revealed that *S. aethiopicum* fruits profusely, producing smaller fruits. *S. gilo* ranked second in terms of fruit production with 107.10±0.88 fruits per plant per plot (Table 4).

CONCLUSION

L. orbonalis incidence occur at all phonological stages of the eggplant varieties screened, with peak infestation occurring at the fruiting stage. The results from this study has shown that the five eggplant varieties screened varied in their susceptibility to *L. orbonalis* with the following ranking of susceptibilities: *S. gilo* > *S. aethiopicum* > *S. ex-lantan*; *S. macrocarpon* > while *S. melogena* was found to be fairly resistant to *L. orbonalis*. Results also indicated that *L. orbonalis* infestation significantly affected some growth and yield parameters of the eggplants assessed.

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Table 1: Monthly abundance of *L. orbonalis* adult moth

Variety	Month				
	May	June	July	Aug.	Sept.
S. aethiopicum	0.24 ± 0.01	1.13 ± 0.06	1.61 ± 0.13	2.92 ± 0.68	3.78 ±0.24
S. ex-lantan	0.00 ± 0.00	0.56 ± 0.36	1.05 ± 0.70	2.06 ± 0.24	2.92 ±0.87
S. gilo	0.50 ± 0.05	1.61 ± 0.04	1.91 ± 0.40	3.59 ± 0.13	4.73 ±1.20
S. macrocarpon	0.05 ± 0.08	0.49 ± 0.13	0.94 ± 0.58	1.79 ± 0.40	2.90 ±0.05
S. melogena	0.00 ± 0.01	0.05 ± 1.10	0.64 ± 0.53	1.18 ± 0.79	1.82 ±0.11
$LSD_{0.05}$	NS	0.41	0.46	0.31	0.61

NS – Not significant

Table 2: Population of *L. orbonalis* adult moth and percent larval infestation per month

Month	No. of *L. orbonalis* adult moth	% Larval infestation
May	0.79	2.06
June	3.84	9.98
July	6.15	15.99
August	11.54	29.99
September	16.15	41.98
Total	38.47	100

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Table 3: Population of *L. orbonalis* and percent larval infestation per variety

Variety	No. of *L. orbonalis*	% larval infestation
S. aethiopicum	9.67	25.14
S. ex-lantan	6.60	17.16
S. gilo	12.35	32.10
S. macrocarpon	6.16	16.01
S. melogena	3.69	9.59
Total	38.47	100

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Table 4: Effect of *L. orbonalis* larval infestation on some agronomic parameters of five varieties of eggplants

Variety	No. of fruits per plot	Fruit weight (t/ha)	Fruit diameter (cm)	Fruit length (cm)	Shoot girth (cm)
S. aethiopicum	128.50±1.20	2.39±0.50	1.96±1.77	1.99±0.53	1.68±1.42
S. ex-lantan	56.60±1.00	1.30±0.23	4.41±0.13	5.94±0.79	2.30±0.86
S. gilo	107.10±0.88	3.82±1.40	4.86±0.70	4.81±1.20	2.38±1.06
S. macrocarpon	50.80±1.20	1.69±0.08	5.04±0.40	6.18±0.47	2.39±0.66
S. melogena	33.20±0.79	1.99±1.00	4.58±0.58	19.76±0.68	2.48±0.37
$LSD_{0.05}$	33.57	0.69	0.25	1.73	0.33

Table 5: *L. orbonalis* larval damage on shoots and fruits

Variety	Length of feeding tunnel	No. of holes per fruit	No. of holes per shoot
S. aethiopicum	1.53±0.09	2.06±0.37	2.13±0.03
S. ex-lantan	1.38±1.00	1.06±0.10	1.00±0.20
S. gilo	2.76±0.20	2.56±0.05	2.75±0.20
S. macrocarpon	1.32±0.05	1.38±0.11	1.06±0.05
S. melogena	0.60±0.01	0.81±0.27	0.48±0.20
$LSD_{0.05}$	0.51	0.34	0.47

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Table 6: Effect of *L. orbonalis* larval infestation on eggplant fruit and fruit related parameters

Variety	% infested fruits	% uninfested fruits	Damage yield (t/ha)	Marketable yield (t/ha)
S. aethiopicum	67.88±1.55	32.12±0.41	2.52±1.00	0.53±1.50
S. ex-lantan	58.58±0.78	41.42±0.58	1.79±0.57	0.58±1.20
S. gilo	70.68±1.20	29.32±1.68	4.51±0.66	0.53±1.50
S. macrocarpon	57.88±1.31	42.12±1.63	1.63±1.00	0.87±0.93
S. melogena	50.44±0.40	46.98±1.44	0.83±0.80	1.32±1.30
$LSD_{0.05}$	23.11	11.30	Ns	0.28

Ns – Not significant

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Performance of Different Varieties of Okra (*Abelmoscus esculentus* (L) Moench) Grown under Irrigation in Kashere, Gombe State.

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Abstract
Field experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Federal University, Kashere, Gombe State to study the Performance of Different Varieties of Okra (Abelmoscus esculentus (L) Moench) Grown under Irrigation in Kashere, Gombe State. The treatment consisted of three okra varieties (Chalawa, NHAe47 and Yarkwadon) grown at a spacing of 60cm x 45cm. The experiment was laid out in randomized complete block design and replicated three times. Data were collected on plant height, number of branches per plant, number of fruits per plant, fruit length, fruit diameter, fresh fruit weight, days to first and 50% flowering, days to first and 50% fruiting and fruit yield per plot which was converted in fruit yield per hectare. Data was analysed using ANOVA and means were separated using LSD at $p \leq 0.05$. Results obtained showed that Yarkwadon gave the highest fruit length (12.16cm), number of branches per plant (12.67), plant height (73.77cm) and number of fruits per plant (14.67) while NHe47 gave the highest fruit yield per hectare of 12.30tha-
Key Words: Okra, Yarkwadon, Irrigation, NHAe47

INTRODUCTION

Okra (*Abelmoscus esculentus* (L) Moench) is a popular vegetable crop grown in most parts of Nigeria and other tropical and sub-tropical countries. It is a member of the malvaceae family (Katung, 2007). The crop is usually grown in Nigeria for its mucilaginous content. The pods vary in length, colour and smoothness depending on the variety and it grows best in well drained rich soils. Okra is an erect annual plant that may grow up to 2m in height; the stems are green, sometimes with red traces, hairy and woody when mature. The leaves are 10- 20 cm long and broad, lobed with 5-7 lobes. The flowers are 4-8cm in diameter. Pods which contain numerous seeds are long or cylindrical and slimy when cut, their size and shape vary, pods are hairy in young stage, furrowed splitting along length when ripe (Edmond *et al*., 1999).
The crop is high in fibre and the raw fruits contain 90% water, 7% carbohydrate, 2% protein and 1% minerals (Rosa, *et al*.. 2010). Mucilaginous extract from okra is reportedly useful in curing ulcer as well as relief of dealing in sugar processing. Scheppes, (2000) noted that the tender pod contains vitamin A and C and also traces of vitamin B. Okra provides good source of calcium and other body building minerals that contributes to healthy living. Okra fruit provide numerous health benefits which are useful in treating cardiovascular, coronary heart diseases, diabetes, digestive disease, genitor urinary disorders and chronic dysentery (Peter, 2011). Okra is cultivated mainly for its immature fresh fruits which are used as vegetables in making soup or dried and milled to powder for use as flavouring (Philips *et a*l., 2010). The stems and leaves of okra are used as animal feed; the seeds are dried and ground for making coffee. World production of okra as fruit

vegetable is estimated at six million tons per year. In West Africa, it is estimated at five to six hundred thousand metric tons (500,000 to 600,000 tonnes) per year (Burkill 1997).

Okra grows best in hot summer with minimum and maximum temperatures of 18^0C (65^0 F) and 35^0C (95^0 F) respectively and need a long season with warm nights. Okra planted in late spring may remain vegetative until late summer or early fall (Sadiq *et al., 1998*). It can be grown both as rain fed and irrigated crop. () repeated. Okra is a popular vegetable in tropical and subtropical countries of the world, and it is grown for it 'Pod" (Adelakum et *al*, 2010).

Okra is a multipurpose crop due to various uses of the fresh leaves, buds, flowers, pods, and seeds (Mihretu *et al,* 2014*)*. It is currently grown mainly as a vegetable crop and has potential to be cultivated as an essential oil seed crop with (20-40%) oil content (Sorapong, 2012). Okra tolerates a wide variety of soils, but prefers a well-drained sandy loam with pH of 6-7 and soil with high organic matter content. The pod mucilage has its medicinal properties as an emollient laxative and expectorant. It also contains protein which plays a particular important role in human nutrition. Okra has been called "a perfect villagers vegetable" because of its robust nature, dietary fibre and distinct seed protein balance of both lysine and tryptophan amino acid unlike the protein of cereals and pulses. The leading world producing Okra countries are India with 483,300 tons per year while Nigeria is second with 139,000 million ton in 2.7 million hectares. Others are Sudan, Iraq and Coted`Ivore with 223,650 million tons, 132,015 and 115,867 million tons, respectively on percentage basis. India alone account for 67% of world production followed by Nigeria with 15% and Sudan with 3% while Iraq and Coted'Ivore with 2%, respectively (FAO, 2010).

Okra production in the study area is usually rainfed which consequently result to unavailability of the vegetable during the dry season. It is obvious that scarcity and high cost of okra need to be addressed through increased production under irrigation. The result of the study will determine the adaptability and yield of okra in Kashere under irrigation. This work was carried out to determine the performance of different varieties of okra under irrigation.

MATERIALS AND METHODS

Field experiment was carried out at the Teaching and Research Farm of Faculty of Agriculture, Federal University, Kashere, Gombe State. The study area is located at an elevation of 431m above sea level on latitude 9^0 46 0 and longitude 10^0 57 0 E, on the northern fringes of the Sudan savannah belt of Nigeria. The treatments consisted of three varieties of okra namely; Chalawa, NHAe47, and Yarkwadam, spaced at 60x45cm inter and intra row. Each variety was allocated to a plot measuring 16.5 m x 16.5 m, making three plots per block and was laid out in Randomized Complete Block Design (RCBD) replicated three times. Surface irrigation was used to supply the water to the crop.

Data Collection

Plant height (cm): Plant height was measured using meter rule from ground surface to the apex of the terminal bud. This was carried out at 4, 8, 12 and 16 weeks after sowing. Three plants were randomly selected from each plot and

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tagged and their individual heights were measured. The mean plant height was then computed.

Number of branches per plant: Branches of the three tagged plants were counted at 12 and 16 weeks. The mean number of branches per plant was then computed.

Number of days to first and fifty percent flowering: The plots were regularly inspected and the number of days to first and fifty percent flowering were duly recorded

Number of days to first and fifty percent fruiting: These were obtained by regular observation of the plots to record the number of days the first fruit appeared and the days it took for the crops to reach fifty percent fruiting.

Number of fruit per plant: At each harvest, the fruits from each plant were counted and summed up to obtain the total number of fruit per plant.

Fresh fruit weight (g): Fresh fruit weight were measured using weighing balance at each harvest and the means recorded.

Fruit diameter (cm): Fruit diameter was measured using venier caliper and the means recorded**.**

Fresh fruit yield per hectare (kg/ha) or (t/ha): To get the fresh fruit yield per hectare, the fresh fruit yield per plot at each harvest was summed up and then converted into fresh fruit yield per hectare.

Fresh fruit yield per hectare (t/ha) =

$$\frac{\text{Total Fresh fruit yield/plot (kg)}}{\text{Area of plot (m}^2\text{)}} \times 10{,}000$$

Data analysis

The data collected were subjected to analysis of variance (ANOVA) as described by Gomez and Gomez (1984), using mixed model procedure of Statistical Analysis System (SAS) (8). and significant means obtained from the analysis were separated using Least Significant Difference at ($p \leq 0.05$).

RESULTS

The result shows the performance of different varieties of okra on plant height of okra grown under irrigation which indicated that there was no significant difference among varieties on plant height at 4 and 8 WAS (Table 1). However, significant differences ($P \geq 0.05$) were observed at 12 WAS and highly significant ($p < 0.01$) at 16 WAS. Yakwadom had the highest plant height (73.77 cm) followed by NHAe47 with 69.77 cm and Chalawa had the lowest plant height of 67.83cm.

There was no significant difference ($P \leq 0.05$) among the varieties in number of branches at 12WAS but significantly different at 16 WAS (Table 2). At 12 and 16 WAS, Yakwadom had the highest number of branches with values of 10.67 and 12.67, respectively while Chalawa had least values of 8.89 and 10.63, respectively.

The results indicated that days to first and 50% flowering and first and 50 % fruiting were not significantly different at $p > 0.05$ (Table 3). However, NHAe47 had the highest values (64.00, 84.00, 70.37 and 90.000 of first flowering, 50 % flowering, first fruiting and 50 % fruiting, respectively while Chalawa had the least values in all parameters.

Results showed that no significant difference was observed in fruit length, fruit diameter and fresh fruit weight at ($p < 0.05$), however, there was significant difference in fresh fruit yield per hectare where NHAe47 produced significantly higher fruits yield than both Chalawa and Yarkwadom which produced the least fruit yield per hectare (Table 4) 12.30t/ha, 8.77t/ha, and 12.07t/ha.

DISCUSSION

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Table 1 showed that Yarkwadon had the highest plant height (73.77) at 16WAS. Some varieties of okra are taller in height, while others are dwarf, because of this there is variation in the plant height. Table 2,showed that there was significant difference in number of branches among the varieties. Yarkwadom had the highest number of branches (12.67) followed by NHAe47. This is in line with the work of Mogapi *et al.* (2014) who reported that okra varieties have varying branching habit. The number of branches per plant may be due to increase in number of branches and leaves, which might have contributed to increase in photosynthetic ability of the plant. This facilitated growth and increase in number of branches. Chalawa started flowering 61.00 days, NHAe47 64.00 and Yarkwadom 61.33 days after planting. It took Chalawa 79.67days, NHAe47 84.00 and Yarkwadom 82.23 respectively to reach the 50% flowering. This was in line with finding of Ekwu and Nwokwu (2012), who reported that, days to first flowering can be affected by varieties and climate. The response of okra variety on days to first and 50% flowering can be attributed to the utilization of solar radiation which usually varies in length, colour and smoothness depending on the varieties (katung, 2007). The outcome of the study revealed that days to first fruiting Chalawa started earlier than the other varieties at 66.67 days after sowing (DAS).while NHAe47 attained the days to first at 70days and Yarkwadom reached fruiting at 67.67 days. Still Chalawa was the variety that attained 50% fruiting at 90 days after sowing. The significant difference among varieties on days to first and 50% fruiting might be due to genetic makeup, environmental influence and solar radiation. The result shows that NHAe47 gave the highest fresh fruit weight (12.30t/ha), fruit diameter (3.77cm), and Yarkwadom gave the highest fruit length (12.16cm), and Number of fruit per plant (14.67). This is in line with the work of Oke (2003).

The effect on number of fruit per plant may due to increase in number of branches and leaves, which might have contributed to increase in photosynthetic ability of the plant and some of which might have been petitioned to fruits for their development (Mogapi *et al* ., 2014). The significant effect on varieties on weight of pod might be due to the excess amount of water content than the others which make their fresh pods to weight higher (Farooq *et al*., 2010).

SUMMARY

The field experiment was carried out at Teaching and Research Farm of the Department of Agriculture, Federal University of Kashere, Gombe State to determine the performance of different varieties of Okra *(Abelmoschus* e*sculentus (L.) Moech*) under irrigation at Kashere. The experiment which was arranged in a randomized complete block design (RCBD) consisted of three Varieties Chalawa, NHAe47 and Yarkwadom, replicated three times. parameters measured were; Plant height, number of branches, number of pod per plant, fruit length, fruit diameter, fresh fruit weight, days to first and 50% flowering, Days to first and 50% fruiting. The data obtained were subjected to statistical analysis of variance (ANOVA) using which software package? .The results showed that there was no significant difference in days to first and 50% flowering, days to first and

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50% fruiting. Significant effect was however, observed in plant height at 12 and 16 WAS, number of branches at 16 AWAS, number of fruit per plant and fresh fruit weight and NHe47 gave the highest (12.30 t/ha) fruit yield per hectare followed by Yarkwadom with value of 12.07 t/ha while Chalawa gave the least (8.77 t/ha) fruit yield per hectare.

CONCLUSION

Based on the finding of this study, it can be concluded that NHAe 47 had the highest yield compared to Yarkwado and Chalawa and thus could be adopted for planting under irrigation in Kashere.

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Table 1. Performance of different varieties of okra on plant height grown under irrigation in Kashere

	Plant height (cm)			
Treatment	4WAS	8WAS	12WAS	16WAS
Chalawa	2.50	5.23	18.83	67.83
NHAe47	2.36	6.03	19.77	69.77
Yarkwadom	2.60	8.06	23.77	73.77
Level of significance	N.S	N.S	*	**
LSD	NS	NS	3.01	3.85

NS: No significance, WAS: week after sowing, LSD, Least significance difference.

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Table 2. Performance of different varieties okra on number of branches of Okra in Kashere

	Number of branches	
Chalawa	8.89	10.63
NHAe47	9.53	11.53
Yarkwadom	10.67	12.67
Level of significance	N.S	*
LSD	2.562	1.652

LSD: Least Significant Difference WAS: weeks after sowing.

Table3. Performance of different varieties of okra on days to first flowering, days to 50% flowering, days to first fruiting and 50% fruiting in Kashere

Treatment	DFL	D50%FL	DFR	D50%FR
Chalawa	61.00	79.67	66.67	86.00
NHAe47	64.00	84.00	70.37	90.00
Yarkwadom	61.33	82.23	67.67	88.33
Level of significance	N.S	N.S	N.S	N.S
LSD	8.07	5.24	9.01	4.60

NS: No significance, DFL: Days to first flowering, D50%Fl: Days to 50% flowering. DFR: Days to first fruiting, D50%FR: Days to 50% fruiting.

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Table 4: Performance of different varieties of okra on yield parameters under irrigation in Kashere.

Treatment	FL(cm)	FD(cm)	NF/P	FFW(t/ha)
Chalawa	10.37	3.30	12.67	8.77
NHAe47	10.01	3.77	13.00	12.30
Yarkwadom	12.16	2.97	14.67	12.07
Level of significance	N.S	N.S	N.S	*
LSD	2.128	0.953	2.070	1.816

FL: Fruit length, FD: Fruit diameter, NF/P: Number of fruit per plant, FFW: Fresh fruit weight

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Growth and Yield Response of Pepper (*Capsicum annum* L*)* to Varying Rates and Spraying Regime of Moringa Leaf Extract

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Abstract
The study evaluated the influence of Moringa leaf extract (MLE) and spraying regime on the growth and yield of sweet pepper during the 2018 early cropping season. Three rates of MLE (0, 50% and 100% concentration) and three spraying regimes (no spray, weekly spray, bi-weekly spray) were utilized. The experimental design was a 3 x 3 factorial in randomized complete block design replicated three times. Data were collected at 4,6,8 and 10 weeks after transplanting(WAT) on plant height (cm), number of leaves, canopy spread (cm), stem girth (cm), fruit number/plot, fruit weight (t/ha), fruit length (cm) as well as fruit diameter(cm). Results indicated that the Moringa leaf extract significantly ($p<0.05$) increased the growth and yield parameters measured relative to the control. . MLE application gave highest plant height of 79.3 cm at 10 WAT, while weekly spray recorded highest plant height of 78.1 cm also at 10 WAT. Weekly spray at 10 WAT showed higher stem girth of 1.6 cm although, this value was not significantly ($p>0.05$) different from the value (1.5 cm) obtained from the bi-weekly application. The interaction of MLE and spraying regime on plant height was not significant ($p>0.05$).The MLE increased the number of fruits, fruit weight, fruit length and fruit diameter relative to the control. Highest values on number of fruits (72), fruit weight (1.96 t/ha), fruit length (3.4 cm) and fruit diameter (2.48 cm) was obtained at 100 % concentration rate of application which was significantly ($p<0.05$) different from the control. Also, weekly spray gave better yield increases in number of fruits (78), fruit weight (1.48 t/ha) and fruit length (3.7 cm) although these values were not statistically different from that obtained from bi-weekly spray. The interaction effects of MLE and spraying regime on fruit weight, fruit length and fruit diameter was not significant.
Key words*; Growth and yield response, Moringa leaf extract, Pepper, Spraying regime,*

INTRODUCTION

Pepper (*Capsicum annum* L.) which belongs to Solananceae is an important vegetable which can be consumed fresh as well as processed is a good source of vitamins and minerals. Moreover, it is one of the valuable medicinal plants in pharmaceutical industry because of its high amounts of antioxidant, capsaicin and capsantin which are the main active substances in it (Aminifard *et al*., 2012).It is also rich in vitamins A and C and contains appreciable quantities of proteins and minerals (Temu and Temu, 2005). Pepper is the second most important vegetable in the world after tomato and used mainly as spices in various cuisines (Olaniyi and Ojetayo, 2010). Nigeria is the largest producer of pepper in Africa and is cultivated mainly in the savanna and derived savanna zones of the South West and also in the North. (Olaniyi and Ojetayo, 2010; Abdulmalik *et al*., 2012). *Moringa oleifera* is the most widely cultivated genus in the family*Moringaceae.* It is a tropical crop grown for its nutritional and medicinal purposes (Foidl*et al*., 2001). The leaves arerich in zeatin, a naturally-occurring cytokinin and other growth enhancing compounds like ascorbates, vitamin E, phenolics and minerals (Foidl *et al*., 2001; Nagar*et al*.,2006).Also *Moringa oleifera* were found among the most promising species according to their high antioxidant activity, high contents of micronutrients and phytochemicals, processing properties, ease of growing and palatability. According to Bharahi,(2003), Moringa plant is known to have high amount of essential nutrient, beta

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carotene. Apart from medicinal uses, the plant leaves are a good source of amino acid and could be used as immune booster. All part of moringa tree are useful and have long been used by humans (Fahey, 2015). The leave also provide excellent materials for the production of biogas (Kivevele, *et. al*; 2011).

Foliar spray of crops with moringa leaf extract (MLE) accelerates plant growth, promotes resistance to stress and increases yield of crops (Fuglie, 1999; Foidl *et al*., 2001; Fahey, 2005; Marcu, 2005). Moringa is a common plant in households in this sub region, its extract can increase crops yields farmers can embrace the technology and utilize the available resource with little or no cost. The frequent and occasional excessive use of chemical inputs have been indicted for adverse effects on the environmental quality because they have potentials to upset the ecological balance of soils and make plants even more susceptible to pests and diseases (Panayotov *et al*., 2010; Fawzy *et al*. 2012). There is now a growing demand for sound and ecologically compatible and environment friendly techniques in agriculture, capable of providing enough food for the increasing human population; retaining soil quality and improving the quality and quantity of agricultural produce (Russo *et al*. 2012). In view of these, the use of natural growth enhancers has been advocated. Therefore, this work is aimed to investigate the effects of varying concentrations of moringa leaf extract (MLE) on the growth and yield of pepper (*Capsicum annuum*).

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research farm of National Horticultural Research Institute (NIHORT) Mbato out- station Okigwe to assess the response of pepper to varying rates and spraying regimes of Moringa leaf extract (MLE). The experimental site had been used to crop water melon after which it was left fallow for one year. The physico-chemical analysis of the experimental site before the commencement of the trial showed that the soil was acidic with textural characteristics of sandy loam. The soil was low in total Nitrogen, Organic carbon, ECEC and base saturation (Table 1). The experiment was a 3 x 3 factorial arranged in a randomized complete block design (RCBD) replicated three times. The treatments consisted of three levels of MLE (0, 50 % concentration, 100 % concentration) and three spraying regimes (no spray, weekly spray, bi-weekly spray). The pepper variety used for the trial was sourced from NIHORT Ibadan. Nursery preparation was done in April, 2018 and transplanted in June, 2018 on raised beds measuring 2 x 2 m at spacing of 50 x 50 cm. NPK 20:10:10 compound fertilizer was applied as basal dose. Pepper stands were sprayed with Cypermethrin$^{(R)}$ (insecticide) weekly at the rate of 30 ml per 10 liters of water to control insect pest attack. Weeding was carried out at four weeks interval. Data were collected at 4, 6, 8 and 10 WAT on plant height, number of leaves, canopy spread and number of branches. Also yield parameters were collected on fruit number per plot, fruit weight per plot,fruit length as well as fruit diameter. Plant height was measured with a meter rule from the surface of the soil to tip of the tallest leaf. Number of leaves, number of branches and fruit number were calculated by counting. Fruit yield was determined by weighing. Fruit diameter was measured using venire caliper. Six (6) candidate plants were used to obtain information from the plots.

Data analysis

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All data collected were analyzed using analysis of variance (ANOVA). Treatment means were separated using Fisher's least significant difference (LSD) at 5 % probability level test.

RESULTS AND DISCUSSION

Effect of Moringa leaf extract and spraying regime on growth and yield of pepper

Growth parameters

The study showed that there was no significant ($p>0.05$) effect of the Moringa leaf extract and spraying regime on plant height. However, at 50% concentration MLE application gave highest plant height of 79.3 cm at 10 WAT, while weekly spray recorded highest plant height of 78.1 cm also at 10 WAT (Table 2). Similar trend of results were obtained with stem girth, but with 100% concentration rate of application showing highest stem girth of 1.9 cm at 10 WAT. Weekly spray at 10 WAT showed higher stem girth of 1.6 cm although this value is not significantly ($p>0.05$) different from the value (1.5 cm) obtained from the bi-weekly application. The interaction MLE and spraying regime on plant height was not significant ($p>0.05$) (Table 2).

The effect of MLE and spraying regime on canopy spread is shown on Table 3. The treatment applications increased the canopy spread relative to the control. At the 100% concentration rate of application, MLE significantly ($p<0.05$) increased the canopy spread compared with the control but not significantly different ($p>0.05$) with 50% concentration. Weekly spray showed highest increase in canopy spread. The interaction effects of MLE and spraying regime was not significant. The MLE increased the number of leaves relative to the control. The results showed that there was no significant interaction between the MLE and the spraying regime on number of leaves. The spraying regime also showed increases in the number of leaves compared with the control.

Yield parameters

The MLE increased the number of fruits, fruit weight, fruit length and fruit diameter relative to the control (Table 4). Highest number of fruits(72), fruit weight (1.96 t/ha), fruit length (3.4 cm) and fruit diameter (2.48 cm) was obtained at 100 % concentration rate of application which was significantly ($p<0.05$) different from the control. Also, weekly spray gave better yield increases in number of fruits (78), fruit weight (1.48 t/ha) and fruit length (3.7 cm) although these values were not statistically different from that of bi- weekly spray. The interaction effects of MLE and spraying regime on fruit weight, fruit length and fruit diameter was not significant.

The increases in both growth and yield parameters of sweet pepper using MLE confirms that moringa leaf is a foliar plant nutrient (Fuglie, 1999), and hence, has the ability to improve the growth and yield parameters measured. Foidl*etal*., (2001) reported that moringa leaves are credited with high protein content and a lot of minerals and vitamins. According to Maker and Becker (1997), moringa leaves have complete set of all the essential amino acids which serves as an excellent source of plant nurients . The yield increases recorded with moringa leaf extract also confirms the report of Akanbi *etal*., (2017) who disclosed that the juice extracted from the leaves of moringa can be used to make foliar nutrient capable of increasing crop yield. Foliar spray of crops with moringa leaf extract accelerates plant growth, promotes resistance to stress and increases yield of

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crops (Fuglie, 1999, Foidl *etal*, 2001, Fahey, 2005, Marcu, 2005).

CONCLUSION

The study revealed that the growth and yield of sweet pepper can be enhanced using Moringa leaf extract at 100% concentration rate of application when sprayed at weekly interval to ensure better yield. The use of MLE should be introduced to resource poor farmers who may not be able to afford inorganic fertilizers that are scare with associated high cost. There is need to emphasize on the use of organic materials such as Moringa leaf extract that can sustain crop yield and improve the condition soils.

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Table 1:Physico - chemical characteristics of the experimental site

Properties	**0- 15 cm**	**15 – 30 cm**
Sand (%)	81.80	80.80
Silt (%)	6.00	6.80
Clay (%)	12.20	12.40
pH	5.26	5.13
Organic matter (%)	2.71	2.60
Total Nitrogen (%)	0.05	0.05
Available P(mg/kg)	11.01	10.96
Ca (cmol/kg)	0.10	0.12
Na (cmol/kg)	0.06	0.05
K (cmol/kg)	0.10	0.12
Mg (cmol/kg)	1.40	1.20
Exchangeable Acidity(cmol/kg)	2.68	2.40
Base saturation (%)	56.30	54.83

Table 2: Effect of Moringa leaf extract and spraying regime on plant height (cm) and stem girth (cm) at 4,6,8 and 10 weeks after transplanting

	Plant height				Stem girth			
Moringa Leaf Extract(MLE)	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**
0	56.7	66.0	66.5	70.7	1.21	1.30	1.30	1.39
50 % conc.	60.8	62.6	66.83	79.3	1.42	1.66	1.70	1.70
100% conc.	64.3	65.5	76.5	79.0	1.58	1.58	1.82	1.90
LSD(0.05)	NS	NS	NS	NS	NS	NS	0,88	0.82
Spraying regime								
No spray	51.0	59.2	66.4	70.0	0.83	1.02	1.02	1.13
Weekly spray	58.2	68.5	78.1	73.6	1.32	1.38	1.38	1.60
bi – weekly spray	73.6	75.6	73.4	81.0	1.46	1.58	1.58	1.50
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS
MLE X Spraying regime	70.5	70.1	78.8	68.9	1.30	1.28	1.62	1.54
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS; Not Significant

Table 3:Effect of Moringa leaf extract and spraying regime on Canopy spread (cm) and number of leaves at 4,6,8 and 10 weeks after transplanting

	Canopy Spread				Number of Leaves			
Moringa Leaf Extract(MLE)	**4WAT**	**6WAT**	**8WAT**	**10WAT**	**4WAT**	**6WAT**	**8WAT**	**10WAT**
0	45.0	47.6	55.1	59.6	76	79	79	86
50 % conc.	61.7	60.9	68.0	71.9	101	110	110	126
100% conc.	66.6	70.4	72.3	74.3	74	84	90	92
LSD(0.05)	7.8	8.3	10.5	7.6	NS	14.8	15.3	9.4
Spraying regime								
No spray	58.8	50.9	62.4	66.2	77	83	87	99
Weekly spray	61.2	65.5	65.5	69.5	93	96	108	115
bi – weekly spray	62.0	63.8	64.1	67.4	84	95	105	127
LSD(0.05)	NS	NS	NS	NS	3.1	3.7	5.2	6.1
MLE X Spraying regime	60.1	62.0	60.8	84.1	77	68	86	115
LSD(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

NS; Not Significant

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Table4:Effect of Moringa leaf extract and spraying regime on number of fruit/plot, fruit weight, fruit length and fruit diameter

Moringa Leaf Extract (MLE)	Number of fruit/plot	Fruit weight (t/ha)	Fruit length (cm)	Fruit diameter (cm)
0	50	0.46	2.4	1.26
50 % conc.	68	1.42	3.4	2.15
100% conc.	72	1.96	3.4	2.48
LSD(0.05)	12.2	0.03	NS	NS
Spraying regime				
No spray	59	0.68	2.36	1.37
Weekly spray	78	1.50	3.54	2.24
bi – weekly spray	70	1.48	3.7	1.98
LSD(0.05)	2.5	0.16	NS	NS
MLE X Spraying regime	79	1.36	3.3	2.44
LSD(0.05)	5.3	NS	NS	NS

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Allelopathic Effects of Tropical Spiderwort (*Commelina benghalensis* L.) Powder on the Performance of African Eggplant (*Solanum macrocarpon* L.)

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Abstract
This experiment was carried out to investigate the allelopathic effect of Commelinabenghalensis on the performance of Solanum macrocarpon. The experiment was carried out at Federal College of Agriculture, Moor Plantation, Ibadan (Latitude 7º 22'N, Longitude 3º 05'E). The whole plants of Commelinabenghalensiswereuprooted and washed in clear water, later air-dried to a constant weight and grinded to powdery form, packaged and arranged indosages; 0 (control), 3,200, 6,400, 9,600, 12,800 and 16,000kg/ha, respectively. This was broadcasted on each plot size 1 m by 1 m thoroughly mixed with the soil using a rake and left for 2 days before the seeds of Solanum macrocarpon were sown, the experiment was laid out in randomized complete block design (RCBD). All data collected were subjected to analysis of variance (ANOVA) and significant treatment means were separated using Duncan multiple range test (DMRT) at 5% level of significance. Three plants were tagged per plot tocollect the following data: plant height (cm), stem girth (cm), number of leaves and yield (kg/ha). The results at 8 WAT showed that Solanummacrocarpon treated with 6,400 kg/ha powder of Commelinabenghalensis had highest number of leaves (18.60) and yield (8,530 kg/ha) while those treated with 9,600 kg/ha had lowest number of leaves (13.40) and yield (7,150 tons/ha), respectively. It can therefore be recommended that 6,400 kg/ha powder ofCommelinabenghalensis should be applied on Solanum macrocarpon plants to obtain good and better yield.
Keywords: Allelopathy, Commelinabenghalensis, Solanum macrocarpon, Yield, Stimulatory.

INTRODUCTION

Allelopathy is a form of positive ornegative interaction among organisms that is caused by the action of chemical compounds referred to as allelochemicals (Rice, 1987). Growth cessation by allelopathic compounds cover all life stages from seeds (seed germination, seedling growth, leaf area) till matured plants such as dry matter production (Eikhatib*et al*., 2004).In higher concentration of allelochemicals, seed germination and mitosis were stopped (Peterson *et al*., 2002).

Commelina benghalensis L. a native to tropical and sub-tropical regions in Africa, Asia and the Pacific is one of the world's worst weeds affecting 25 crops in 29 countries (Webster *et al*., 2005). It is fast growing and a prolific seed producer (Walker and Evenson, 1985), with ability to regenerate from stem fragments (Budd *et al*., 1979) and high tolerance to glyphosate. This makes itexceptionally difficult to control in agronomic systems when it becomes established (Culpepper *et al*., 2004). Therefore there is urgent need to find alternative use for this weed biomass in crop production, one of which can be controlling other weeds. The objectives of this study are to determine the allelochemicals present in *Commelina benghalensis* and ascertain allelopathic properties of *Commelina benghalensis* on the performance of *Solanum macrocarpon*.

MATERIALS AND METHODS

The experiment was carried out at Federal College of Agriculture, Moor Plantation, Ibadan (Latitude 7º22' N and Longitude 3º05' E). Each plot was 1 m by 1 m and *S. macrocarpon* seeds were sownusing spacing

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of 25 cm by 25 cm. Composite soil sample (0-20 cm) was collected, air dried at room temperature, crushed and made to pass through a 2 mm mesh sieve and subjected to routine analysis to determine the soil textural class and chemical analysis. The soil test was carried out at the soil laboratory of Federal College of Agriculture, Ibadan

The experiment was laid out in Randomized Complete Block Design (RCBD), with six treatments;3,200, 6,400, 9,600, 12,800 and 16,000kg/ha powdery form of the whole plants of *C. benghalensis* and Control (0 kg/ha) replicated three times. The *C. benghalensis* powder of varying quantitieswas broadcasted on the soil, mixed thoroughly and left for (2) days before the seeds of *S. macrocarpon* were sown. Weeding was done weekly in order to reduce weed infestation and aqueous extract of neem leaves was applied every two days to control Leaf spot disease and Ladybird beetles insect. Three (3) plants were tagged per plot to collect the following data: Plant height (cm) stem girth (cm), Leaf area (cm^2), number of leaves and Weight (kg/ha) of the vegetable. All data collected were subjected to analysis of variance (ANOVA) using SAS version 2009 and significant treatment means were separated using Duncan Multiple Range Test (DMRT) at 5% level of significance.

RESULTS

Table 1 showed that the soil used had a pH value of 6.40 which is slightly acidic, total Nitrogen 0.1 (g/kg), Organic carbon 0.1 (g/kg) (which indicated that Organic carbon was extremely high in the soil) and Available phosphorus 7.4 (g/kg), Calcium 0.3 (Cmol/kg), Magnesium 0.2 (Cmol/kg), Sodium 0.4 (Cmol/kg), Potassium 0.2 (Cmol/kg). The result showed that Potassium is extremely low in the soil. On particle size, the sand was 852 (g/kg), silt 68 (g/kg) and Clay 80(g/kg). Textural class is loamy sand.

Table 2 showed phytochemical result of *C. benghalensis* powder. The powder had low content of all bioactive phytochemicals tested such as Alkaloid, Flavonoid, Phenolic, Saponin and Phytate. Alkaloid content (0.677 ± 0.002)%, flavonoid content (0.0046 ± 0.002)%, Phenolic content (0.427 ± 0.001)%, Saponin content (0.141 ± 0.001)% and Phytate (0.237 ± 0.001)%.

The effect of *C. bengalensis* powder on plant heights of *Solanum macrocapon* was presented in Table 3. At 2 WAT, control experiments had tallest plants (6.09 cm) which was significantly taller than plants treated with 3,200 kg/ha and 12,800 kg/ha powder of *C. bengalensis*. At 4 WAT, there were no significant differences among all treatments; although control experiments were the tallest (8.57 cm) while plants treated with 3,200 kg/ha powder of *C. bengalensis* were the shortest (7.34 cm). At 6 WAT, plants treated with 12,800 kg/ha powder of *Commelinabengalensis* had tallest plants (18.2 cm) which were significantly taller than treatments of 6,400 kg/ha and 9,600 kg/ha powder of *C. bengalensis*. At 8 WAT, plants treated with 12,800 kg/ha powder of *C. bengalensis* were tallest (25.51 cm) and was significantly taller than those treated with 0 kg/ha, 3,200 kg/haand9,600 kg/ha (21.80, 21.83 and 21.44 cm, respectively).

Effect of *C. benghalensis* powder on stem girths of *S. macrocapon*was presented in Table 4. At 2 WAT, there was no significant difference among all the treatments, although plants treated with 9,600 kg/ha powder of *C. bengalensis* had widest stem girth (1.53 cm) while plants treated with

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3,200 kg/ha powder of *C. bengalensis* had lowest stem girth (1.34 cm). At 4 WAT, there were no significant differences among all the treatments, although plants treated with 9,600 kg/ha powder of *C. bengalensis* had widest mean stem girth (2.12 cm) while plants treated with 12,800 kg/ha powder of *Commelinabenghalensis* had lowest mean stem girth (1.91 cm). At 6 WAT, there were no significant differences among all treatments, although plants treated with 3,200 kg/ha powder of *Commelina bengalensis*had widest mean stem girth (3.45 cm) while plants treated with 12,800 kg/ha powder of *C. bengalensis* had lowest mean stem girth (3.01 cm). At 8 WAT, there were no significant differences among all the treatments, although plants treated with 9,600 kg/ha powder of *C. bengalensis* had widest mean stem girth (4.52 cm) while plants treated with 6,400 kg/ha powder of *Commelinabengalensis* had lowest mean stem girth (3.84 cm).

Effect of *C. benghalensi s*powder on number of leaves of *S. macrocapon* was presented in Table 5. At 2 WAT, plants treated with 12,800 kg/ha powder of *Commelina bengalensis* had the highest mean number of leaves (7.91) while plants treated with 0 kg/ha and 16,000 kg/ha had least mean number of leaves each (6.33). At 4 WAT, plants treated with 6,400 kg/ha powder of *C. bengalensis* had highest mean number leaves (11.04) which was significantly higher than those treated with 0 kg/ha, 3,200 kg/ha and 16,000 kg/ha (8.50, 8.60 and 8.36, respectively). At 6 WAT, plants treated with 6,400 kg/ha powder of *C. bengalensis* had the highest mean number of leaves (14.28) and was significantly higher than all other treatments. At 8 WAT, plants treated with 6,400 kg/ha powder of *C. bengalensis* had highest mean number of leaves (18.60) which was significantly higher than treatments 0 kg/ha, 9,600 kg/ha and 16,000 kg/ha (14.56, 13.40 and 15.38, respectively).

The effect of *C. benghalensis* powder on yield of *S. macrocapon* was presented in Table 6. At 8 WAT, there were no significant differences among all the treatments though plants treated with 6,400 kg/ha powder of *C. bengalensis*had highest yield (8,530 kg/ha).

DISCUSSION

The results of this work indicated that lower dosage of 6,400 kg/hapowder of*Commelinabenghalensis* stimulates the plant height, number of leaves and yield of *S. macrocarpon*. This is in line with Mvumi*et al*. (2012) who reported that moringa leaf extract increased growth and yield of tomato i.e spraying of moringa extract every 2 weeks from 2 weeks after transplanting gave the highest fresh fruit weight of 31.88 tons/ha. Also, this work is similar to that of Mao *et al*. (2010) who reported that aqueous extracts of *Bidenspilosa* with low concentration of 20 mg/ml had some stimulatory effect on bud growth of *Trifoliumrepens* and *Medicago sativa* while high concentrations of 100 mg/ml had a considerable inhibitory effect on seed germination and seedling growth.

CONCLUSION

This study has shown that *C. benghalensis* powder have allelopathic effect on *S. macrocapon* plants. At 8 WAT, application of6,400 kg/ha powder of *C. benghalensis* gave 8,530 kg/ha which was higher than all other treatments. This indicated that *C. benghalensis* powder had stimulatory type of effect on the *Solanum macrocapon* plants. It is also observed that higher dosage of *C. benghalensis* powder reduced performanceof *S. macrocapon* plants.

Therefore, 6,400 kg/ha powder of *C. benghalensis* can be used to stimulate the performance of *S. macrocapon* plants.

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Table 1: Physical and chemical properties of the soil

Parameter	Value
pH	
Available Phosphorus	7.4
Organic Carbon (g/kg)	0.1
Organic Matter (g/kg)	0.2
Total Nitrogen (g/kg)	0.1
Exchangeable Bases (Cmol/kg)	
Ca	0.3
Mg	0.2
K	0.2
Na	0.4
Particle size (g/kg)	
Sand	852
Silt	68
Clay	80
Textural class	Loamy sand

Table 2: Quantitative phytochemical results of *Commelina benghalensis* extract

Phytochemicals compounds	Composition (%)
Alkaloinds	0.679± 0.002
Flavonoids	0.0046±0.002
Phenolic	0.427±0.001
Saponin	0.141± 0.001
Phytate	0.237+ 0.001

Results are means of duplicate determination ± standard deviation.

Table 3: Effect of *Commelina bengalensis* powder on the plant height (cm) of *Solanum macrocapon* at 2, 4, 6 and 8 weeks after transplanting

Quantity of *Commelina* powder (kg/ha)	2 WAT	4 WAT	6 WAT	8 WAT
0	6.09^{a}	8.57	13.38^{b}	21.80^{b}
3,200	4.80^{b}	7.34	13.31^{b}	21.83^{b}
6,400	5.04^{ab}	7.59	16.14^{ab}	22.66^{ab}
9,600	5.17^{ab}	7.73	15.38^{ab}	21.44^{b}
12,800	4.66^{b}	8.14	18.23^{a}	25.51^{a}
16,000	5.11^{b}	7.97	16.25^{ab}	23.74^{a}

Means with the same letters in a column are not significantly different from one another at DMRT $p < 0.05$. WAT =Weeks after transplanting.

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Table 4: Effect of *Commelina bengalensis* powder on stem girth (cm) of *Solanum macrocapon* at 2, 4, 6 and 8 WAT

Quantity of *Commelina* powder (kg/ha)	2 WAT	4 WAT	6 WAT	8 WAT
0	1.36	1.92	3.16	4.21
3,200	1.34	1.92	3.45	4.45
6,400	1.42	1.88	3.18	3.84
9,600	1.53	2.12	3.36	4.52
12,800	1.43	1.91	3.01	4.01
16,000	1.44	2.06	3.15	3.89

Means with the same letters in a column are not significantly different from one another at DMRT $p < 0.05$. WAT =Weeks after transplanting.

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Table 5: Effect of *Commelina bengalensis* powder on the number of leaves of *Solanum macrocapon* at 2, 4, 6 and 8 WAT

Quantity of *Commelina* powder (kg/ha)	2 WAT	4 WAT	6 WAT	8 WAT
0	6.33ab	8.50b	9.90c	14.56c
3,200	7.33a	8.60b	12.12b	16.47ab
6,400	7.91a	11.04a	14.28a	18.60a
9,600	7.41a	8.82ab	10.15c	13.40c
12,800	7.58a	9.50ab	12.25b	16.76ab
16,000	6.33ab	8.36b	11.01bc	15.38b

Means with the same letters in a column are not significantly different from one another at DMRT $p < 0.05$. WAT =Weeks after transplanting.

Table 6: Effect of different dosages of *Commelina benghalensis* powder on the yield (kg/ha) of *Solanum macrocapon*

Quantity of Commelina powder (kg/ha)	Yield (kg/ha)
0	7.36^{b}
3,200	7.25^{b}
6,400	8.53^{a}
9,600	7.15^{b}
12,800	7.29^{b}
16,000	8.64^{a}

Means with the same letters in a column are not significantly different from one another at DMRT $p < 0.05$. WAT =Weeks after transplanting.

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Preliminary Study of Cucumber (*Cucumis sativus* L.)Yield Attributes and Yield to Organic Mineral Fertilizer Application at Samaru

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Abstract
One of the efforts to increase the production of Cucumber is by using fertilizer in the cultivation area with low fertility soils.A field trial was conducted at Institute for Agricultural Research, Samaru during the 2017 wet season to study the response of cucumber yield attributes and yield to organomineral fertilization. The treatments consisted of six (6) levels of fertilizer (0, 100, 200, 300, 400 kg ha^{-1} organomineral fertilizer and 300 kg ha^{-1}recommended NPK fertilizer) laid in randomized complete block design (RCBD). The treatments were replicated four times. The result indicated that fruit length significantly increases with increased application of organomineral fertilizer. However, higher rate of organomineral 400 kg ha^{-1} had similar fruit length with recommended rate NPK fertilizer. A similar trend was observed in fruit weight plant^{-1} and fruit yield ha^{-1}. From the findings it can be concludedthat application of 300 kg ha^{-1} of Organomineral fertilizer was found to produced similar yield when compared with recommended NPK fertilizer rate
Keywords: Cucumber, Organomineral fertilizer, yield

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is a vegetable crop that provides huge nutritional benefits with low in *calories* but high in many important vitamins and minerals. It supplies daily fiber and vitamin C. They also "provide small amounts of vitamin K, vitamin C, magnesium, potassium, manganese and vitamin(Murad and Nyc, 2016).It is well known fact that application of organic combined with or without inorganic fertilizer to soil is considered as a good management practices in any agricultural production system because it improves plant quality and soil fertility. The scarcity and high cost inorganic fertilizer coupled with soil degradationeffect posed a great concern to agricultural production while on the other hand organic manures are alternative source of nutrients to vegetable production but has its own limitations such as availability, bulkiness and transportation.The need for renewable forms of energy and reduced addition of inorganic fertilizer to crops, have revivedthe use of organic manures worldwide (Ayoola and Adeniran, 2006). Improvement in environmental conditions and public health are important reasons for advocating increased use of organic materials (Ojeniyi, 2000; Maritus and Vleic, 2001). Organomineral fertilizer is defined as a fertilizer obtained by blending, chemical reaction, granulation, or dissolution in water of inorganic fertilizers having a declarable content of one or more primary nutrients with organic fertilizers or soil improver (Anon, 2012).

The organomineral fertilizers used by many researchers were individual and manually compounded and this may lead to nutrient imbalance. The use of bio solids-based

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organomineral fertilizers addresses an important issue of nutrient cycling in the agricultural ecosystems. The use of such products represents a technological advancement compared with ways that sewage sludge has been traditionally recycled in agriculture, and it appears to be in line with the current environmental and regulatory frameworks Antille (2011). Recently National Research Institute for Chemical Technology (NARICT) has embarked the production of organomineral fertilizers (organic waste and inorganic fertilizers). Enhanced quality of organic-basedfertilizer materials can provide an opportunity to improvecrop profit margins by means of reduced input costs offertilizers while delivering some of the environmental benefitsassociated with recycling.Little research has been conducted on the response of vegetables to organomineral fertilizers.The objective of this study was to determine response ofcucumberto organomineral fertilizer derived from neem based nutrient-enriched biosolids granules.

MATERIALS AND METHODS

A field study was carried out in 2017 at the Institute for Agricultural Research (IAR) farm (11^0 11'N 07^0 38'E) 686 metres above sea level in the Northern Guinea Savanna of Nigeria. The treatment consisted of six (6) levels of fertilizer (0, 100, 200, 300, 400 kg ha^{-1} organomineral fertilizer and recommended NPK fertilizer 300 kg ha^{-1}) laid in randomized complete block design (RCBD). The treatments were replicated four times. The plot size for cucumber 4 x 5 m.Prior to the experiment, composite soil samples were collected from the field using a soil auger with diameter of 15 cm and subjected to routine analysis. Seed was chemically treated with Apron star at 3.0 gm per 5 kg of seed before planting. Butachlor 60EC was applied pre-emergence at rate of 3 kg a.i ha^{-1} using knapsack sprayer for weed control of early emerging weeds. Two seeds were planted and later thinned to one per hill at 3 weeks after planting. The trial received a split (½) dose of fertilizer at 3 weeks and second dose at 6 weeks after planting. Manual weeding was carried out at 3 and 5 weeks after planting. Insect pests were controlled with (Lamdacyahalothrin 2.5 EC) at 2L ha^{-1} biweekly intervals for effective insect control starting from 6 weeks after planting.The data collected include fruit length, fruit weight $plant^{-1}$ and fruit yield t ha^{-1}. All the data collected were subjected to analysis of variance (ANOVA) using general linear procedure with Statistical Analytic Software (SAS, 2009) and treatment means were compared using Duncan Multiple Range Test (DRMT).

RESULTS AND DISCUSSION

The results of the measured physical and chemical properties of the soil are summarized in Table 1.The results showed that the content of N = 1.09 g kg^{-1}, Available P = 10.1cmol kg^{-1}, Exchangeable K = 0.331cmol kg^{-1}, C-Org = 0.90 g kg^{-1} while soil slightly acidic. The soil texture was also characterized as loam. This explains that the N and organic carbon content were low. However, the values of N and K were below the critical values of thenutrients in the soil while available P adequate for cucumber production the area.

Table 2 showed the effect of treatment on fruit length, fruit weight per plant and fruit yield ha^{-1}. Fruit length significantly increases with increased application of organomineral fertilizer. However, higher rate of organomineral 400 kg ha^{-1} had similar fruit length with recommended rate NPK fertilizer. Application of organomineral fertilizer at 400 kg ha^{-1}

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significantly produced higher fruit weight per plant and yield t ha^{-1} than the control treatment. Application of 300-400 kg ha^{-1} of organomineral and recommended NPK fertilizer rate were similar in fruit weight per plant and yield t ha.$^{-1}$ The heavier fruit weight and fruit yield were obtained from NPK treatment may probably due to faster release of nutrient contents of NPK than organomineral fertilizer treatment. Similar reports have been made on faster nutrient release from inorganic fertilizers compared to organic nutrients sources when used for the production of vegetables, cereal and tree crops (Ainika *et al*., 2012; Adeoye *et al*., 2008).

Conclusion and Recommendation

It can be concluded that application of 400 kg ha^{-1} of Organomineral fertilizer was found to produce similar yield when compared with recommended NPK fertilizer rate. However it is recommended that higher rate of organomineral fertilizer beyond 400 kg ha^{-1} should be used to achieve optimum rate for cucumber production in the study area.

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Table 1.Physical and Chemical analysis of soil at Samaru 2017.

Physical Properties	**Value**
Sand (g kg^{-1})	440
Silt	300
Clay	260
Textural class	Loam
Chemical Properties	
pH (in 2: 1 water)	5.08
Organic carbon g kg^{-1}	0.90
Nitrogen g kg^{-1}	1.09
Ca^{++} mg kg^{-1}	8.80
Mg mg kg^{-1}	0.95
Available P cmol kg^{-1}	10.1
Exchangeable K cmol kg^{-1}	0.33

Source: Department of Agronomy Ahmadu Bello University, Zaria

Table 2: Response of Cucumber to Organomineral Fertilizer Application on fruit length (cm), fruit weight (kg) and Yield (t ha^{-1}) at Samaru

Treatment	Fruit length (cm)	Fruit weight (kg) $plant^{-1}$	Yield (t ha^{-1})
Fertilizer rate kg ha^{-1}			
0	9.07d	3.3b	5.1c
100	9.93d	4.7b	5.3c
200	10.3cd	4.7b	6.2bc
300	11.3bc	10.7ab	9.8ab
400	22.7a	11.7ab	9.9ab
NPK (Rec rate 300)	12.5ab	13.0a	11.0a
SE±	0.41	2.60	1.30

Means within a column with the same letter(s) do no differ significantly at 0.05 level of probability using New Duncan Multiple Range Test (NDMRT)

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Influence of Seedling Age on the Growth of Tomato (*Lycopersicon esculentum* Mill.)

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***Abstract**:*
The experiment was conducted at National Horticultural Research Institute; Bagauda Station which is located at latitude 11^{0}33N and longitude 8^{0}23E in 2017 to determine the influence of seedling age on the growth of tomato **(***Lycopersicon esculentum Mill***.).** *The design used was Randomized Completely Block Design (RCBD) with 5 treatmentsi.eD1T (18days), D2T (22days), D3T (26days), D4T (30days) and D5T (34days) after planting which was replicated 5 times. The growth parameters plant height, stem girth, leaf area and leaf segment were recorded 2, 4 and 6 weeks after last transplant.From the result the longest plants were D1T (18 days) with 14.397, D4T (30 days) with 12.647 and D4T (22 days) with 12.507 which were similar. The shortest plant was D5T (34 days) with 6.625 at 2weeks after last transplant. At 4weeks D1T (18 days) with 23.060 was the longest plants. The shortest plant was D5T (34 days) with 10.21. At 6weeks D1T (18 days) with 41.333 andD4T (22 days) with 37.846 were the longest plants. The shortest plant was D5T (34 days) with 21.972. Stem girth was statistically the same for all the treatments at 2 weeks and 6weeks, D1T (18 days) with 2.5347 which was statistically similar to D4T (30 days) with 2.4993have the widest stem at 4 weeksand D5T (34 days) with 1.5408 has the narrowest stem. At 2 and 4weeks D1T (18 days) with 6.805 and8.111 has the largest leaf area and highest number of leaf segments while D5T (34 days) with 2.032 and 4.271 has the smallest leaf area and lowest number of leaf segment. There was no significant difference inleaf area and leaf segment parameters in all the treatments at 6weeks after last transplant.*
***Keywords**: Seedling age, Tomato, Transplant, Growth*

INTRODUCTION

Tomato (*Lycopersion esculentum* Mill.) belonging to the family Solanaceae, is one of the most popular and widely grown vegetable crop in the world. Tomato is warm season crop and highly susceptible to frost and high humidity and perishable in nature (Goto *et al.,* 2010). It is a staple fruit vegetable, one of the most important vegetables worldwide (Saeed-Awan *et al.,* 2012) considered as an important cash and industrial crop in many parts of the world (Ajagbe *et al.,* 2014) that has become popular over the last century. It is world's largest vegetable crop after potato and sweet potato(Abdullah et al., 2010). The people who eat tomato regularly reduced risk of cancer disease and it has detoxification effect in the body. It is high in water soluble vitamins and minerals, essential amino acids, sugars, dietary fiber, low in fat and calories; main source of vitamins A, B, C, iron, phosphorous, protein, edible oil and lycopene (Achoja and Okoh, 2014). Tomato

is a perennial crop butsome cultivars are grown as annual crop in some part of the world.

Few literatures and researches about seedlings right age for transplanting are available. The seedlings either die due to being very fragile and tender when transplanted at a very young age, or become susceptible to attack by pathogens and mechanical damage when transplanted at older age leading to high yield loss. Therefore, transplanting seedlings of proper age is of utmost importance. With this, optimal age of seedlings for transplant is essential to finding out the right stage of transplanting in tomato under the Sudan Savanna Agro climatic condition.

MATERIAL AND METHODS

The experiment was conducted at National Horticultural Research Institute; Bagauda Station which is located at latitude $11^0$33N and longitude $8^0$23E in 2017 to determine the influence of seedling age on the growth of tomato (*Lycopersicon esculentum* Mill.). The station is located in Sudan savanna agro climate. Tomato variety Peto 86 was collected from seed unit in the station. The experiment comprised of five (5) treatmentsD1T (18days), D2T (22days), D3T (26days), D4T (30days) and D5T (34days) after planting which was replicated 5 times.

The nursery bed of 50cm x 50cm was prepared and tomato seeds were sown and watered. When the seedlings were about to be ready for transplanting, land preparation harrowing, ridging and other agronomic practices were carried out. The first transplant was carried out after 18 days after sowing, and then it was followed with subsequent set of transplants with intervals of four (4) days between each set. Data of growth parameters were recorded on five (5) tagged tomato plants two (2) weeks after the last set of transplant three (3) times at two (2) weeks interval. The design used was randomized completely block design and the plot size was 2m^2. The data were first taken 2weeks after the last set of transplant and observations were analyzed statistically using SAS.

RESULTS AND DISCUSSION

The result obtained showed that different treatments of seedling of tomato influenced some of the growth parameters.

Plant Height

From the result in Table 1, 2 and 3, the longest plants were D1T (18 days) with 14.397, D4T (30 days) with 12.647 and D4T (22 days) with 12.507 which were similar. The shortest plant was D5T (34 days) with 6.625 at 2weeks after last transplant. At 4weeks D1T (18 days) with 23.060 was the longest plants. The shortest plant was D5T (34 days) with 10.21.At 6weeks D1T (18 days) with 41.333 andD4T (22 days) with 37.846 were the longest plants. The shortest plant was D5T (34 days) with 21.972.

Stem Girth

Stem girth was statistically the same for all the treatments at 2 weeks and 6weeks, D1T (18 days) with 2.5347which was statistically similar to D4T (30 days) with 2.4993have the widest stem at 4 weeks and D5T (34 days) with 1.5408 has the narrowest stem.

Leaf Area

At 2weeks D1T (18 days) with 6.805 has the largest leaf area while D5T (34 days) with 2.032 has the smallest leaf area. At 4weeks D1T (18 days) with 10.765 has the largest leaf area while D5T (34 days) with 4.099 has the smallest leaf area. There was no significant difference for leaf area parameters in all the treatments at 6weeks after last transplant.

Leaf Segment

At 2weeks D1T (18 days) with 8.111 has the highest number of leaf segments while D5T (34 days) with 4.271 has the lowest number of leaf segment. At 4weeks D1T (18 days) with 10.200 has the largest number of leaf segments while D5T (34 days) with 5.600 has the smallest number of leaf segment. There was no significant difference for leaf segment parameters in all the treatments at 6weeks after last transplant.

CONCLUSION

On the overall performance D1Twhich was the first transplant (18 days after sowing) though statistically similar with some of treatment is some parameter, it performed

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better in almost all the growth parameters observed. This makes it the best time to transplant among all the other treatments.

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Table 1: Growth of tomato at 2 weeks after last transplant as affected by seedling age

Day of transplant	Plant height 2weeks	Stem Girth	Leaf area2weeks	Leaf segment
D1T	(cm)	2weeks (cm)	(cm^2)	2weeks (cm)
D2T	**14.289a**	**0.9733**	**6.805a**	**8.111a**
D3T	**12.507a**	**1.0093**	**5.227ab**	**6.533ab**
D4T	**10.247ab**	**0.9187 1.0083**	**3.481ab**	**5.793ab**
D5T	**12.647a**	**0.8103**	**5.428ab**	**7.733a**
Mean	**6.625b**	**0.94397**	**2.032b**	**4.271b**
CV	**11.2627**	**18.6987**	**4.59453**	**6.48825**
SE±	**33.3034**	**0.17651**	**58.5608**	**25.5427**
Level of significance	**0.57427** *	NS	**2.69059** *	**1.65727** *

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Table 2:Growth of tomato at 4 weeks after last transplant as affected by seedling age

Day of transplant	Plant height 4weeks (cm)	Stem Girth 4weeks (cm)	Leaf Area 4 weeks(cm^2)	Leaf segment 4 weeks(cm)
D1T				
D2T	**23.060a**	**2.5347a**	**10.765a**	**10.200a**
D3T	**18.407ab**	**2.2347ab**	**7.027ab**	**8.333ab**
D4T	**14.795ab**	**2.0768ab**	**7.371ab**	**8.393ab**
D5T	**18.627ab**	**2.4993a**	**9.046ab**	**10.067a**
Mean	**10.213b**	**1.5408b**	**4.099b**	**5.600b**
CV	**17.0204**	**2.17726**	**7.66160**	**8.51866**
SE±	**36.8904**	**24.3584**	**48.5786**	**24.1555**
Level of significance	**6.27891** *	**0.53034** *	**3.72190** *	**2.05773** *

Table 3: Growth of tomato at 6 weeks after last transplant as affected by seedling age

Day of transplant	Plant height 6weeks (cm)	Stem Girth 6weeks (cm)	Leaf area 6weeks (cm^2)	Leaf segment 6weeks (cm)
D1T	**41.333a**	**3.2153**	**13.798**	**12.77**
D2T	**34.713ab**	**3.1843**	**9.949**	**31.33**
D3T	**30.333ab**	**2.8940**	**10.873**	**12.16**
D4T	**37.846a**	**3.4807**	**13.071**	**11.64**
D5T	**21.972b**	**2.5120**	**6.560**	**8.62**
Mean	**33.23947**	**3.05726**	**10.8504**	**15.3042**
CV	**31.7571**	**27.6731**	**55.1126**	**133.257**
SE±	**10.5559**	**0.84604**	**5.97994**	**20.3941**
Level of significance	*	NS	NS	NS

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Influence of Cold and Heat Substrate Pre-Treatment Methods on the Growth and Yield of three Oyster Mushrooms (*Pleurotus pulmonarius, P. ostreatus,* and *P. florida)*

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Abstract
Pleurotus species, (oyster mushrooms) are cultivated worldwide and are one of the most widely cultivated mushrooms. Substrate preparation for these mushrooms is usually done by heat (pasteurization or sterilization using autoclave).This study was aimed at evaluating other alternative and easy procedure of substrate pretreatment for these mushrooms in comparison to the conventional heat treatment method. Three cold sterilization methods, using calcium hydroxide, hydrogen peroxide and sodium hypochlorite(bleach) baths were studied where heat treatment served as the control. Three species of oysters (Pleurotuspulmonarius, P. ostreatusand p. florida) were investigated andthe results obtained showed that the oysters took significantly less time (11 days on the average) to race through the substrate compared to the heat pre-treatment method (20 days). Days to primodial initiation were significantly (P< 0..05) shorter(18.82) on the cold treated substrates than the control (29.83). Daily mycelial extension was also highest (1.18cm) on the control and least (0.79) on the cold treated ones. The biological efficiency (BE)was significantly highest on the control (57.25%) compared to the cold treated substrate as well as the production efficiency. This findings substantiate the efficacy of substrate heat pretreatment method, however, cold substrate pretreatment method is equally viable, cheaper and less laborious.
Key word: *Oyster mushrooms, substrate pretreatment, Mycelia growth, Biological efficiency*

INTRODUCTION

Mushrooms are fungi. They are saprophytes living on dead organic matter such as plant residues and other wastes containing lignin, cellulose and hemi cellulose. They secrete extra cellular enzymes which help in digesting the complex organic matter on which they grow (Oie, 1996).

Oyster mushrooms are the second largest commercially cultivated mushrooms in the world (Royse, 2013). They have high culinary value with exotic taste and are rich in quality proteins, vitamins and minerals. Their low content of fat and sodium made them suitable for people with heart related diseases (Quimio et al, 1990).

Mushrooms are conventionally grown on treated lignocellulosic wastes, the wastes are subjected to heat treatments of various types such as autoclaving, pasteurization by steam or hot water by immersion (Stamets, 2000). This study aimed at comparing heat treatment substrate pretreatment methodwith the use of different chemical pretreatment methods rice straw as basal substrate testing its effects on growth and yield attributes of some oyster nushrooms.

MATERIALS AND METHOD

This experiment was conducted at the Mushroom research/ production section of the Vegetable Research Programme of National Horticultural Research Institute, Ibadan, Nigeria. The cultures of the oyster mushrooms (*P. pulmonarius, P. ostreatus*and *P. florida)* used in this study were generated by tissue culture of young fruiting bodies on potatoto dextrose agar. The cultures were refrigerated (4^0C) until needed.The spawn was prepared according to the method of Quimio*et al,*(1990).

Guinea corn(*Sorghum bicolor)*was washed soaked in water overnight, drained, parboiled for 15 minutes, drained again and bottled in 200ml bottles with each bottle containing 150g of seeds (wet weight). The bottled seeds were autoclaved at 121^0C for

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15 minutes. After cooling, the bottles were then seeded with the freshly prepared cultures above and were kept for 2 weeks for the mycelia of the various mushrooms to ramify the seeds to give the mother spawn. The planting spawn was generated by preparing *sorghum* seeds as outlined above, the seeds were then inoculated with the freshly prepared mother spawn following the same procedure.The fruiting substrate was prepared with rice straw chopped into sizes of 2-3cm and wereseparately soaked in solutions ofhydrated lime, (calcium hydroxide) prepared at a concentration of 10g/liter, household bleach (Jik, Reckit Benckiser Nigeria Limited, Agbara, Ogun State, Nigeria.) at 5ml/liter and hydrogen peroxide (Analar by BDH Chemical Limited, Poole, England.) at 5ml/ liter.

Three 15liter capacity plastic buckets were filled with 10 liter of water each to which calcium hydroxide, hydrogen peroxide and sodium hypochlorite(household bleach) of the above concentrations were individually added to each bucket. Equal volume of the chopped rice straw was added to each bucket, submerged in the solutionand held down with weights. The buckets were separately covered, left overnight and drained the following morning.

The drained rice straw from the different treatments was filled in sterile test tubes in triplicates, spawned and covered with aluminum foil to monitor mycelia growth of all the test mushrooms. Polyethylene bags were also stuffed with the drained rice straw from each of the treatment buckets at 300g/bag. Each bag was inoculated with 30g of spawn of the three mushrooms. The bags and test tubes were then moved to the incubation room for further growth. Mycelia growth were measured every other day from the day of spawning. The substrate bags were left undisturbed throughout the period of incubation, at the end of which they were cropped and the mushrooms were harvested and weighed as they appeared.

RESULTS AND DISCUSSION

Absence of contaminants after mushroom substrate pretreatment, spawning and spawn run is indicative of the ability of the substrate pretreatment method applied to prevent the growth of other contaminant microorganisms, Oseni*et al*, (2012). In this study, the different pretreatment methods used had varied effect on the days to substrate colonization ranging from 7.5 to15.5daysfor *P. pulmonarius,* 0 – 10.5 on *P. ostreatus*, 10 – 12 days on *P. florida* and average of 19.5 days for the three mushrooms on the control. This report is contrary to the findings of Atila (2016) who reported spawn run time of 16.8 and 19.9days on hot water and chemical (formaldehide) treatment respectively. Oei, (1991) reported that time taken by mushroom mycelium to ramify its substrate are influenced by growth media type, spawn quantity and spawning method and the prevailing climatic condition of the growing environment.

Number of days to appearance of primodia (mushroom initials) of *P. ostreatus* was shortest on substrates treated with calcium hydroxide and with bleach. *Pleurotuspulmonarius* was observed to have the shortest days to primodia initiation on the control and the longest on the calcium hydroxide bath. *P. florida* initiated shortest on hydrogen peroxide and the longest on the control (Fig 2). Shorter time taken by substrate pretreated by chemicals against those treated by heat may suggest that the mushrooms ceased the window of opportunity to get established in the substrate before the reactivation of the other

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contaminant microorganisms in the substrate. All the mushrooms recorded their shortest daily mycelia extension on substrates treated with calcium hydroxide and the longest on the control. *P. ostreatus* recording no growth at all (Fig3).

Biological efficiency was found to be highest on the control for all the tested mushrooms and lowest in others. *P. pulmonarius* had the highest biological efficiency and the lowest was recorded on the others (Fig 4).These findings implied that the various chemicals evaluated were able to make the competitor microorganisms in the substrate inactive only for some time which gave the mushroom a window of opportunity to race through the substrate. The metabolic activities of the growing mushroom might have changed the properties of the substrate which made the environment conducive for the inactive competitors to become active, hence the low biological efficiency obtained compared to the control in which the competitors were killed by the heat treatment applied. This agrees with the finding of Ali *et al* (2007) who reported that higher yield and BE of fresh fruiting bodies of *Pleurotusspp* were obtained on heat treated cotton wastes than formalin treated ones. Vinoltkumar and Babu, (2013) obtained and reported higher mushroom yield on autoclaved substrate than on cold pretreated substrate.

In conclusion, heat substrate pretreatment method for oyster mushroom cultivation still appeared to be the best, but the cold sterilization methods (calcium hydroxide, hydrogen peroxide and bleach baths) can still be employed as it is cheaper and less cumbersome. It can be used in areas where facilities for heat pretreatment are not readily available.

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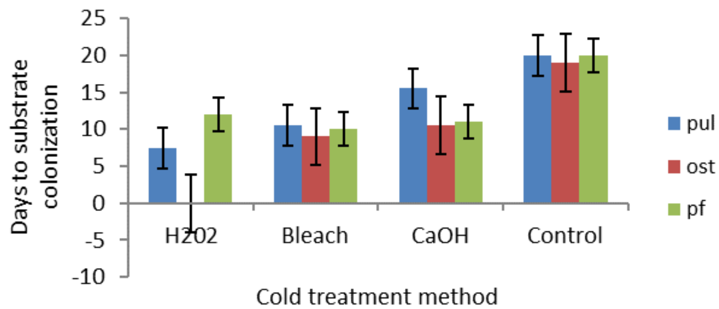

Fig 1: Effect of chemically treated substrates on number of days to mycelia colonization of*P. pulmonarius, P. ostreatus,*and *P. florida*
H_2O_2 = hydrogen peroxide, bleach = sodium hypochlorite, CaOH = calcium hydroxide.
pul= *P. pulmonarius* ,ost= *P. ostreatus*, pf= *P. florida,*

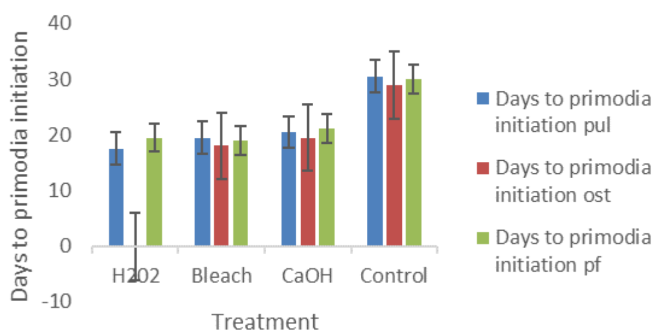

Fig 2: Effect of chemically treated substrate on number of days to primodia initiation of*P. pulmonarius, P. ostreatus*and *P. florida*
H_2O_2 = hydrogen peroxide, bleach = sodium hypochlorite, CaOH = calcium hydroxide.
pul= *P. pulmonarius* ,ost= *P. ostreatus*, pf= *P. florida*

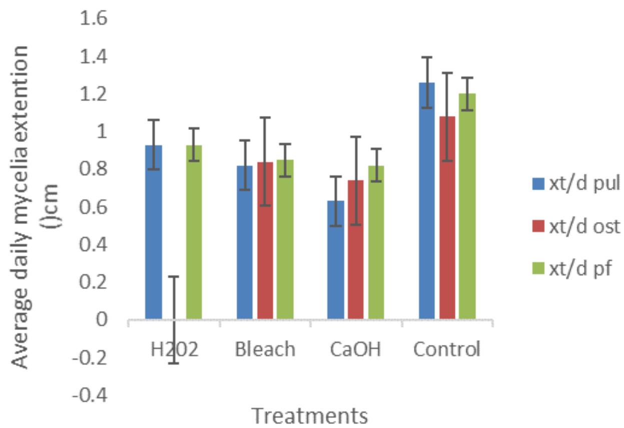

Fig 3: Effect of chemically treated substrate on daily growth of the mycelia of*P.pulmonarius, P.ostreatus*and *P.florida.*
H_2O_2 = hydrogen peroxide, bleach = sodium hypochlorite, CaOH = calcium hydroxide.
xt/d pul= *P. pulmonarius*, xt/d ost= *P. ostreatus*, Xt/d pf= *P. florida*

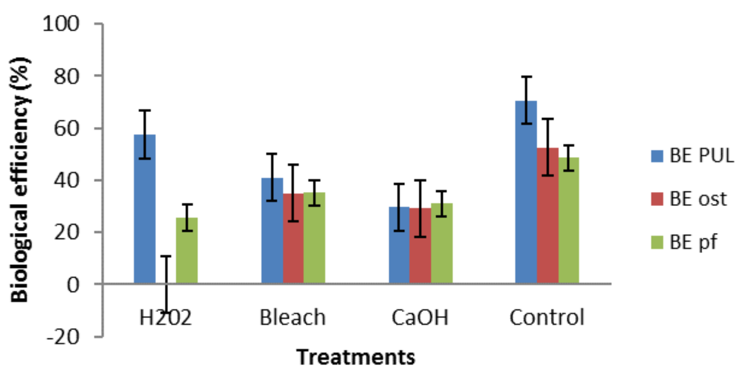

Fig 4: Effect of chemically treated substrates on the biological efficiency of*P. pulmonarius, P. ostreatus*and *P. florida.*
H_2O_2 = hydrogen peroxide, bleach = sodium hypochlorite, CaOH = calcium hydroxide.
BE PUL= *P. pulmonarius*, BE ost= *P. ostreatus*, BE pf= *P. florida,*

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Table 1: Effects of chemically treated substrates on the yield of*P pulmonarius, P.ostreatus*and *P florida*

Treatment	Fruit number			Total fruit weight (g)			Average fruit size (g)			Production efficiency (%)		
	pul	Ost	pf	pul	Ost	pf	pul	ost	Pf	Pul	ost	pf
Hydrogen peroxide	8.50	0.00	5.50	60.39	0.00	26.89	7.13	0.00	4.93	23.09	0.00	9.47
Bleach	9.00	8.00	7.00	42.95	36.82	36.90	4.77	4.68	4.95	16.06	13.72	13.98
Calcium hydroxide	7.50	6.50	7.00	31.11	30.60	32.57	4.16	4.74	4.65	12.32	11.66	11.82
Control	9.30	10.00	9.00	140.19	55.16	51.00	7.83	5.51	5.67	27.08	18.21	17.31
LSD	1.70	2.20	1.39	1.98	0.71	0.96	1.20	1.42	1.22	0.83	0.29	0.48

*Pul = Pleurotuspulmonarius, ost = Pleurotusostreatus*and *pf = Pleurotusflorida*

Table 2: Effects of chemically treated substrates on the growth of*P pulmonarius, P ostreatus*and *P florida*

Trt	Width of pileus			Length of stipe			Mycelia extension (cm)			Mycelia density		
	pul	Ost	pf	pul	ost	pf	pul	ost	Pf	pul	ost	pf
H202	7.00	0.00	6.2o	6.10	0	4.05	9.25	0	9.25	4.70	0	3.90
Bleach	6.55	7.40	6.55	5.55	5.35	5.26	8.20	8.40	8.50	4.58	4.11	4.31
CaOH	6.20	5.65	6.55	5.60	4.10	4.75	6.25	7.40	8.15	3.37	4.36	4.42
Control	8.12	7.50	7.25	7.50	6.30	6.30	12.6	10.8	11.95	4.95	4.98	4.85
LSD	0.14	0.29	0.38	0.22	0.35	0.50	0.37	0.44	0.55	0.10	0.37	0.41

*Pul = Pleurotuspulmonarius, ost = Pleurotusostreatus*and *pf = Pleurotusflorida*

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Growth and Yield of Determinate and Indeterminate Tomato (*Lycopersicon esculentum* Mill) Cultivars as Influenced by Sole Organic and Integrated Fertilizer Types

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Abstract
Improvement work in tomato usually places emphasis on cultivating varieties with desirable growth response to soil fertility management and high yield. Experiments were carried out at Teaching and Research Farm, Federal University of Agriculture, Abeokuta in early growing seasons of years 2014 and 2015, examining growth and yield of tomato as influenced by fertilizer type. Experiment was a Randomized Complete Block Design in split-plot arrangement, replicated three times. Two tomato varieties,Roma VF (determinate) and Beske (indeterminate) constituted the main plots while six fertilizer types (poultry droppings, cow dung, NPK, poultry droppings + NPK, cow dung + NPK and the control) constituted the sub-plots. Data on vegetative and reproductive growth parameters, as well as yield were subjected to analysis of variance. Least Significant Difference and Duncan's Multiple Range Test at 5% probability level were used in respective data sets to compare treatment means. Irrespective of fertilizer type, tomato varieties differed in plant height, number of leaves, branches, days to first and 50% flowering, days to maturity, number of fruits and fruit yield.Variety Beske had taller plants, more leaves and branches per plant and attained first and 50% flowering earlier. Beske had early maturity (50 days) relative to Roma VF (59 days). Variety Beske similarly had higher fruit yield (6.8 t/ha) than Roma VF (4.7 t/ha). Application of poultry manure (5t/ha) + NPK 15:15:15 (150kg/ha) enhanced fruit yield in both varieties. Tomato variety Beske, cultivated withcomplementary application of 5t/ha poultry manure and 150kg/ha NPK 15:15:15 is recommended for high yield.
Key words: *Roma VF, Beske, Poultry manure and Cow dung*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill), an annual herb belonging to the family *solanaceae.* is classified as a functional food, having good levels of vitamins, minerals, and lycopene, a carotenoid pigment that provides red colour and antioxidant qualities (Alvarenga, 2004). The acceptance of crop produce can be influenced by the source of nutrients involved in its production. Many pre- and postharvest factors influence the phytochemical contents of crop produce. Pre-harvest factors of relevance are climatic conditions during production and cultural practices, including fertilizer use (Jeffery *et al.,* 2003). Fertilizer type can influence the level of functional food components in crop produce.

Prativaand Bhattarai (2011) carried out a study and revealed that the integration of organic manures in combination with inorganic fertilizers was found significant in improving the overall plant growth, yield and soil macro nutrient status than the sole application of either of these nutrients.

Hallorans *et al*. (1993) observed that chicken manure did not increase tomato yields significantly but increased the number of large and medium size fruits. Maridha *et al*. (2000) reported that the application of poultry manure significantly increased the tomato fruit yield.

The objective of the study was to determine the influence of sole organic manure type and integrated fertilizer type on growth and fruit yield of determinate and indeterminate tomato.

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MATERIALS AND METHODS

Field experiments were carried out under rain-fed condition, at the Teaching and Research Farm, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria(7° 15'N, 3° 25' E) in years 2014 and 2015. The experiment was laid out in Randomized Complete Block Design (RCBD) in a split-plot arrangement with three replications. Variety was allotted to the main plots and fertilizer to the sub plots. The sub-plot size was 2m x 3m.Tomato seeds were sown and maintained on a ground nursery. Soil sample was taken from the experimental site for pre-planting laboratory analysis. Samples of the cow dung and poultry manure were also analyzed for nutrient status and applied to their respective plots two week before transplanting according to Tirkey *et al*., (2002). Transplanting was done on manually prepared beds when seedlings were four weeks old, at a spacing of 50cm x 50cm (40,000 plants/ha). Two seedlings were transplanted per stand and thinned to one after establishment at two weeks after transplanting.NPK (15:15:15) fertilizer was applied to the allotted plots following Bodunde and Adeniji (2007), with basal fertilizer application at one week after transplanting and top-dressing at four weeks after transplanting. Weeding was done manually as the need arose. Integrated fertilizer application was done by the application of half the recommended rate of organic fertilizer (5t/ha) applied at two weeks before transplanting plus half of the recommended rate of NPK (15:15:15) at 150kg/ha in two split doses. Data collection commenced at 2 weeks after transplanting on vegetative, reproductive and yield parameters. Data collected were subjected to analysis of variance and Least Significant Difference and Duncan's Multiple Range Test at 5% probability level were used, as appropriate, to compare treatment means in respective data sets.

RESULTSANDDISCUSSION

There were observed differences in the two tomato varieties on the growth parameters measured. Variety Beske had taller plants, more leaves and branches compared with Roma VF (Table 3). The two tomato varieties were different in their number of days to first and 50% flowering as well as number of days to maturity as variety Beske attained these three parameters earlier than Roma VF in both years (Table 4). This is attributed to the expected inherent genetic differences in the varieties. Number of days to maturity was apparently determined by number of days to first and 50% flowering.

Differences in yield attributes for the years may be due to differences in the environmental conditions of the years. Variety Beske had more fruits and higher total fruit yield than Roma VF in both years (Table 5). This can be explained with the view of Ghebremarian (2005) who suggested that indeterminate varieties continuously produce flowers and fruits, and consequently higher number, though of small fruit sizes. It was observed that fruit yield could be influenced by the yield variables such that variety that is early in flower production and maturity result in high number of fruits as well as fruit yield as variety Beske was early in flower production and maturity and eventually had more fruits as well as high fruit yield.

Integrated application of poultry manure (5t/ha) with NPK 15:15:15 (150kg/ha) enhanced number of fruits and fruit yield (Table 6). In the first year, Beske plants were taller with the application of sole poultry manure compared to other fertilizer types, while in the second year it was taller with the application of NPK

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15:15:15. Roma VF was taller with the application of cow dung in both years (Table 7).

The two varieties had more fruits and higher fruit yield with the application of sole poultry manure and cow dung in the first year while in the second year only variety Beske showed such superiority (Table 8).

CONCLUSION

Indeterminate tomato variety (Beske) attained days to first flowering, 50% flowering and maturity earlier than Roma VF (determinate) and had more fruits as well as higher fruit yield. Thus, indeterminate tomato variety Beske is recommended with the application of poultry manure (5t/ha) + NPK 15:15:15 (150kg/ha) for good vegetative growth and high fruit yield.

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Table 1: Pre-planting physico-chemical characteristics of soil used for the experiment

Parameters	2014	2015
pH	6.50	6.19
Total Org C (%)	1.98	0.79
Total Nitrogen (%)	0.07	0.08
Phosphorus (ppm)	6.01	6.65
Potassium (ppm)	0.17	0.28
Sodium (cmol/100g)	0.75	0.53
Calcium (mg/kg)	0.22	6.03
Magnesium (cmol/100g)	4.65	1.94
Copper (mg/kg)	0.18	1.1
Manganese (mg/kg)	162.35	38.65
Iron (mg/kg)	11.31	7.95
Zinc (mg/kg)	1.34	5.50
ECEC (mg/100g)	20.00	8.86
Sand (%)	77	86.2
Clay (%)	20.2	5.0
Silt (%)	1.8	6.8
Textural class	Sandy loam	Sandy

Table 2: Characteristics and Composition of Poultry manure and Cow dung used for the experiment

	Poultry manure		Cow dung	
	2014	2015	2014	2015
pH	9.40	7.76	9.3	9.19
Org C (%)	2.41	5.15	2.59	2 89
Total Nitrogen (%)	0.18	0.21	0.20	0.15
Phosphorus (mg/kg)	9.86	9.13	6.32	7.10
Potassium (cmol/100g)	0.40	0.54	0.72	1.03
Sodium (cmol/100g)	25.00	0.54	1.65	1.02
Calcium (mg/kg)	53.59	3.05	5.83	8.55
Magnesium (cmol/100g)	12.26	1.65	1.16	2.77
Copper (mg/kg)	0.33	350	11	14
Manganese (mg/kg)	3.55	724	512	491
Iron (mg/kg)	2325	4026	4837	6923
Zinc (mg/kg)	3.80	4.12	119	128

Table 3: Varietal and Fertilizer effects on growth parameters of tomato at the peak vegetative growth stage (8WAT)

	Plant height (cm)		Number of leaves		Number of branches		Leaf Area (cm^2)	
Treatment	2014	2015	2014	2015	2014	2015	2014	2015
Variety;								
Beske	56.897	75.083	56.897	67.989	8.377	11.283	325.300	1130.60
Roma VF	54.954	69.714	50.761	58.044	6.872	10.239	142.640	933.50
LSD (5%)	0.216	1.385	1.944	1.417	0.656	0.161	99.498	111.923
Fertilizer type								
Poultry droppings (PD)	86.975	85.333	89.900	60.892	14.850	9.867	206.180	1043.10
Cow dung (CD)	86.408	89.542	83.958	78.850	11.983	14.133	250.580	1186.50
NPK	56.858	88.017	52.700	89.458	8.325	14.633	188.450	1689.60
PD + NPK	90.200	95.492	91.275	98.525	19.367	19.642	261.230	1167.40
CD + NPK	23.458	62.190	32.200	61.360	3.275	10.370	95.290	842.40
Control	18.627	55.014	28.945	38.779	1.545	9.000	61.760	877.50
LSD (5%)	11.383	8.658	10.245	8.299	3.050	0.647	22.243	57.771

Table 4: Number of days to first flowering, 50% flowering and maturity of tomato as influenced by variety

	1st Flowering		50% Flowering		Maturity	
	2014	2015	2014	2015	2014	2015
Beske	21.9	30.5	27.4	34.2	40.1	67.2
Roma VF	25.8	32.6	29.9	36.4	54.6	69.3
LSD (5%)	0.8	1.3	0.7	0.8	1.9	0.8

Table 5: Effect of tomato variety on number of fruits and yield (t/ha)

	Number of fruits		Fruit yield (t/ha)	
Variety	2014	2015	2014	2015
Beske	158.35	115.14	6.66	2.14
Roma VF	125.97	79.472	4.58	1.63
LSD (5%)	3.76	6.03	0.97	0.32

Table 6: Effect of fertilizer type on number of fruits and yield (t/ha) of tomato

	Number of fruits		Fruit yield (t/ha)	
Fertilizer type	2014	2015	2014	2015
Poultry droppings	299.830	126.420	9.169	2.573
Cow dung	300.000	138.500	9.346	2.386
NPK	53.670	151.000	2.721	2.691
Poultry droppings + NPK	378.830	159.170	13.057	2.879
Cow dung + NPK	15.420	89.400	0.283	1.760
Control	4.930	46.500	0.121	1.124
LSD (5%)	46.704	22.607	3.209	**0.**082

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Table 7: Interaction of variety and fertilizer type on tomato plant vegetative growth at 8WAT

		Plant height (cm)		Number of leaf		Number of branch		Leaf Area (cm^2)	
Variety	Fertilizer Type	2014	2015	2014	2015	2014	2015	2014	2015
Beske									
	PD	91.62^{a}	85.95^{ab}	111.10^{a}	62.40^{bcd}	17.83^{a}	9.57^{cdef}	660.7^{ab}	236.22^{bcd}
	CD	80.42^{b}	85.70^{ab}	85.88^{bc}	79.82^{ab}	10.30^{bcd}	13.65^{abc}	734.1^{ab}	308.89^{abcd}
	NPK	57.48^{c}	96.72^{a}	75.07^{c}	95.75^{a}	8.50^{cde}	15.22^{a}	254.1^{bc}	453.91^{ab}
	PD + NPK	56.08^{c}	61.15^{cd}	40.70^{d}	43.50^{cde}	5.50^{e}	7.93^{def}	168.7^{bc}	320.91^{abcd}
	CD + NPK	22.25^{d}	55.78^{cde}	11.10^{e}	54.43^{bcde}	1.03^{f}	8.83^{def}	11.9^{c}	220.20^{cd}
	Control	20.13^{d}	65.20^{c}	11.28^{e}	72.03^{abc}	1.00^{f}	12.20^{abcd}	12.8^{c}	289.60^{abcd}
Roma VF									
	PD	82.33^{b}	84.72^{ab}	88.70^{bc}	59.38^{bcd}	11.87^{bc}	10.17^{bcde}	930.9^{a}	261.25^{bcd}
	CD	92.40^{a}	93.83^{a}	102.03^{ab}	77.88^{ab}	13.67^{b}	14.62^{a}	463.4^{abc}	512.96^{a}
	NPK	56.23^{c}	79.32^{b}	50.33^{d}	83.17^{ab}	8.15^{de}	14.05^{ab}	273.8^{bc}	394.94^{abc}
	PD + NPK	64.32^{c}	49.83^{de}	41.85^{d}	33.55^{de}	5.23^{e}	5.35^{f}	252.3^{bc}	127.14^{d}
	CD + NPK	24.67^{d}	63.77^{e}	13.30^{e}	64.33^{bc}	1.52^{f}	11.25^{abcd}	18.4^{c}	317.19^{abcd}
	Control	21.43^{d}	47.27^{e}	8.35^{e}	29.95^{e}	0.80^{f}	6.00^{ef}	13.3^{c}	177.27^{cd}

Note: Means followed by the same alphabet in the same column are not significantly different at 5% probability level of DMRT

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Table 8: Interaction of variety and fertilizer type on tomato yield variables and fruit yield (t/ha).

		First Flowering		50% Flowering		Maturity		Number of Fruits		Fruit Yield (t/ha)	
Variety	Fertilizer Type	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Beske											
	PD	20.00^{de}	30.50^{cde}	23.83^{ef}	27.33^{e}	57.17^{c}	66.17^{bcde}	341.17^{a}	137.67^{ab}	9.49^{a}	2.49^{ab}
	CD	21.50^{d}	29.33^{def}	28.50^{cd}	34.50^{bc}	59.17^{bc}	69.67^{bc}	288.83^{ab}	177.67^{a}	8.64^{a}	2.69^{ab}
	NPK	26.83^{bc}	25.83^{f}	31.67^{bc}	29.00^{de}	65.50^{a}	61.50^{e}	49.67^{cd}	176.00^{a}	1.37^{bc}	3.20^{a}
	PD + NPK	30.50^{ab}	32.67^{bcd}	37.83^{a}	36.67^{abc}	66.50^{a}	68.17^{bcd}	53.83^{cd}	39.00^{de}	2.11^{bc}	0.95^{cde}
	CD + NPK	16.17^{ef}	33.67^{bc}	19.67^{fg}	38.83^{ab}	31.67^{e}	69.67^{bc}	13.67^{d}	83.83^{cd}	0.23^{c}	1.56^{bcd}
	Control	17.33^{def}	30.83^{cde}	20.00^{fg}	38.67^{ab}	36.17^{d}	67.83^{bcd}	6.00^{d}	76.67^{cd}	0.18^{c}	1.96^{abcd}
Roma VF											
	PD	22.33^{cd}	27.67^{ef}	26.50^{de}	32.33^{cde}	59.00^{bc}	66.00^{cde}	258.50^{b}	115.17^{bc}	8.85^{a}	2.66^{ab}
	CD	22.00^{cd}	25.83^{f}	26.33^{de}	31.67^{cde}	59.83^{bc}	63.67^{de}	311.17^{ab}	99.33^{bc}	10.05^{a}	2.08^{abc}
	NPK	29.33^{ab}	28.33^{ef}	35.50^{ab}	33.17^{cd}	63.50^{ab}	64.00^{de}	57.67^{cd}	126.00^{bc}	4.07^{b}	2.19^{ab}
	PD + NPK	32.17^{a}	35.33^{ab}	36.67^{a}	40.00^{a}	65.83^{a}	71.50^{b}	103.83^{c}	39.33^{de}	4.01^{b}	0.81^{de}
	CD + NPK	13.00^{f}	28.33^{ef}	16.33^{g}	34.17^{bc}	31.00^{e}	67.33^{bcd}	17.17^{d}	90.17^{bc}	0.34^{c}	1.90^{bcd}
	Control	17.67^{de}	37.83^{a}	19.67^{fg}	41.17^{a}	36.17^{d}	77.50^{a}	7.50^{d}	6.83^{e}	0.15^{c}	0.13^{e}

Note: Means followed by the same alphabet in the same column are not significantly different at 5% probability level of DMRT

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Effectiveness of Different Pre-Treatments on Seed Germination and Seedling Vigour of *Tetrapleura tetraptera*

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Abstract
Despite its socio-economic importance, the cultivation of Tetrapleura tetraptera is not popular owing to the difficulty in seed germination. As a step in its domestication process, investigations were undertaken on germination requirements to determine the effectiveness of different pre-treatments media on seed germination and seedling vigour of Tetrapleura tetraptera. The seeds were extracted and subjected to the following treatments:100% concentrated tetraoxosulphate vi acid, 50% concentrated tetraoxosulphate vi acid, 100% concentrated hydrochloric acid, 50% concentrated hydrochloric acid, Hot water treatment, Cold water treatment, Sandpaper treatment, and a control experiment (untreated seed). Results showed that mean percentage germination was higher on the seeds treated with 100% H_2S0_4 than on other pre- treatments. While untreated seeds and those soaked in cold water irrespective of the duration of treatment failed to germinate. Soaking seeds in either 100% concentrated HCl or 100% concentrated H_2SO_4 for 5 seconds were the most effective treatments in breaking dormancy, with 78 % and 89 % mean germination recorded respectively. Thus for the production of Tetrapleura tetraptera fruit, H_2SO_4 and HCl can be used to promote germination of its seeds.

INTRODUCTION

Tetrapleura tetraptera (Schumach. and Thonn) is one of the molluscicidal medicinal plants and lesser-known multipurpose tropical tree in Nigeria (Aladesanmi, 2007). The economic and medicinal uses of *T. tetraptera* are many. The fruits are used locally in Nigeria in flavouring, in creams, and in soaps. However, trees exhibit seed dormancy in order to survive unfavorable condition (Carvalho and Nakagawa, 2000). *T. traptera* have a hard coated seeds just like other tropical and leguminous trees, therefore resulting in delay germination. In an ideal condition, germination of the seeds often takes a much longer period compared to the common arable crops (Aref*et al.,* 2011). In view of this, there is a need to enhance the rate of seed germination using pre-treatment.

The significance of subjecting tree seeds to pre-treatment in order to obtain optimum germination, healthy and vigorous seedling has been highlighted by the different researchers (Doran *et al.,* 1983; Tietema *et al.,* 1992; Sahoo, 2007; Olajide*et al.,* 2014; Omokhua *et al.,* 2015; Thangjam and Sahoo, 2017).The germination of hard-coated seeds has been trigger using different pretreatment, among which are acid treatment, hot water, scarification, cold water, nicking, sandpaper etc. According to Rawat (2009), all these pretreatments have been found to enhance seed germination and seedling growth of trees.

These studies also confirmed that trees species respond differently to different media, which mean they have a distinctive preference for some (Bahuguna *et al.,* 1987). Like many other tropical trees, the *T. tetraptera* also have hard-coated seeds which prevent seed germination and thus there is the need to investigate the most appropriate method to break its dormancy. However, scanty information exists on the effectiveness of different pre-treatments media on seed germination and seedling

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vigour of *T. tetraptera*. Therefore, this study aimed to examine the effects of pre-treatment on germination of *T. tetraptera* seeds as well as its seedling vigor.

MATERIALS AND METHODS

The experiment was conducted between July to October 2012 under the screen house of the Department of Crop, Soil, and Pest Management, The Federal University of Technology, Akure.

The planting materials (seeds of *T. tetraptera)* were obtained from Oja-oba market in Akure, Ondo state. The seeds were authenticated in the department after which the infected and diseased seeds were discarded. Selected healthy seeds were air dried and keep at room temperature (28±2°C). Seeds with above average weight were selected and bulked. The sample representative taken from the bulked seeds were used for the experiment. The initial soil test conducted on the soil indicated that the soil is slightly acidic (5.64), with organic carbon of 1.26%. The selected seeds were subjected to different pre-treatments viz; 100% concentrated tetraoxosulphatevi acid, 50% concentrated tetraoxosulphate vi acid, 100% concentrated hydrochloric acid, 50% concentrated hydrochloric acid, Hot water treatment, Cold water treatment, Sandpaper treatment, and control; where no treatment was applied.

Pre-nursery/pre-planting procedures: 100% of H_2SO_4 was prepared by measuring 100ml of H_2SO_4in a conical flask. The 50% of H_2SO_4 was prepared by measuring 50ml of distilled water and 50ml of Conc. H_2SO_4 in a conical flask in the laboratory. A similar procedure was used in measuring 100% and 50% of HCl. Seeds of *T. tetraptera* were soaked in the prepared media for 5 seconds, removed, and rinsed in distilled water before they were sowed according to Tietema (1992).

For the hot-water treatment, ten seeds were dipped into hot water at 100°c for five minute. They were left to cool on the laboratory bench under room temperature and sowed afterwards Onyekwelu(1990). The cold water treatment was setup by soaking ten seeds of *T. tetraptera* in cold water for 48 hours, after which they were sowed (Onyekwelu, 1990).

For the sand-paper treatment, the seeds were rubbed between two rough surfaces of sandpaper for three minutes before planting (Onyekelu,1990). In the case of the control experiment, the ten seeds were sowed without applying any of the pre-sowing treatment.

Nursery procedure: Germination were monitored daily and recorded. The first germination was observed five days after planting, while the last germination was observed after six after. Two weeks after germination, the number of plant stands per treatment were thinned to three plant stands. Potting of healthy and vigorous seedlings began a week after thinning. Three (3) seeds of *T. tetraptera* were planted per pot to give a total of 72 seedlings. Potting of healthy and vigorous seedlings was done using a well-perforated polythene bag filled with farrowed forest top-soil. The weed control was done manually (hand-pulling) as at when due and watering was done daily.

Experimental Design: the experiment was laid out in Complete Randomised Design (CRD) and replicated three times

Data Collection and Analysis: Germination count was determined by visual observation and this was done on a three days interval, to note if there was a sign of soil bulging up or opening.

Percentage germination was determined after seedling emergence using the formula:

X/Y x 100

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Where X= germinated seeds for each treatment,
Y= total number of seeds planted for each treatment.

The following growth parameters were collected: plant height, stem girth, number of leaves, and number of branches. Data collected were subjected to analysis of variance (ANOVA) using SPSS version 17 and means separated using Duncan Multiple Range Test (DMRT).

RESULTS

The % germination of *T. tetraptera is* presented in Table 1, the result revealed that seed germination was influenced significantly by various pretreatments. Furthermore, the result showed that 100% of H_2SO_4 had the highest and maximum seed germination percentage (89), followed by seed exposure to 50% H_2SO_4 (78). The following treatments had equal % germination (67): 100% HCl, % 50 HCl and sandpaper. The cold water treatment and control had 56% while the hot water treatment had the least percentage germination rate of 45. However, the seed treated with 100% H_2SO_4showed significantly ($P<0.05$) higher germination compared to control while other pretreatments also showed significantly ($P<0.05$) higher germination.

The result presented in Table 3showed the correlation for the growth parameters. Plant height of *T. tetraptera* had a positive and highly significant correlation with number of branches, The number of branches had a positive and significant correlation with number of leaves. The correlation between plant height and number of branches had the highest positive and significant correlation (0.97), followed by number of branches and plant height (0.82). However no negative correlation between the parameters.

DISCUSSION

The differences in germination attributes for the treated and untreated seeds might be due to altered physiology of embryos and liberating enzymes so that processes occur more rapidly after sowing the seeds. The application of conc. H_2SO_4 at 100% treatment gave the highest germination. The absolute concentration (100%) of H_2SO_4 and HCl gave the best performance among the pre-treatments. A similar study conducted by Alaba *et al*. (2006) on *T. tetraptera* revealed that subjection of the seeds to absolute sulphuric acid, heat treatment at 100 C and mechanical scarification using sandpaper for 7 minutes resulted in 90%, 16%,and 80% germination, respectively.

Results from the study have clearly demonstrated that application of pre-sowing treatments proved beneficial as it markedly improved growth parameters of *T. tetraptera* compared to the control. It showed that the application of 100% H_2SO_4 in breaking the dormancy of seeds of *T. tetraptera* followed by 100%HCl, 50% H_2SO_4 and 50% HCl were effective in improving most of the parameters (plant height, number of leaves and number of branches) studied. Cold water treatment was not significantly different from control (untreated).

Although the control also performed well which means that the seeds of *T. tetraptera* are capable of germinating naturally without any pre-sowing treatments. But the exposure of the seed to 100% H_2SO_4 and HCl, reflect the need or importance of pre-sowing treatment in the breaking of dormancy of hard coat seed and the seedling vigour of the seeds of *T. tetraptera,*

CONCLUSION

The seed dormancy in *T. tetraptera* is mainly due to the hard seed coat, which affects the seed germination. The results obtained in this study emphasized the

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necessity of treating *T. tetraptera* seeds before sowing, in order to enhance its growth. Applying pre-sowing treatments to break the seed dormancy of *Tetrapleuratetraptera*using 100% H_2SO_4, 100% HCl, and sandpaper treatment proved effective compared with hot and cold water treatment which had no significant difference from the control.The pre-germination treatment of *T. tetraptera* seeds by using 100% H_2SO_4, 100% HClenhanced germination of theseeds, heightand number of leaves of seedlings. Thus for the production of *T. tetraptera* H_2SO_4 can be used to promote germination of its seeds. But for the benefit of the average peasant gardener who may not have access to 100% H_2SO_4, and 100% HCl, soaking tne seeds of *T. tetraptera* in hot water for five minutes is highly recommended.

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Table 1: Effect of different pretreatments on Seed germination of*Tetrapleura tetraptera*

Treatments	%Germination
100% H_2SO_4	89a
50% H_2SO_4	67c
100% HCl	78b
50% HCl	67c
Hot-Water	64c
Cold-Water	56d
Sand Paper	67c
Control	45e

Table 2: Effect of different pretreatments on growth parameters of *Tetrapleura tetraptera*

Treatments	Seedling height (cm)	Number of leaves	Girth (cm)
100% H_2SO_4	38.30a	23.67a	0.49a
50% H_2SO_4	28.43c	20.00d	0.49a
100% HCl	34.67b	22.00b	0.49a
50% HCl	28.43c	20.67e	0.48a
Hot-Water	26.87c	17.67c	0.49a
Cold-Water	16.97e	12.00e	0.48a
Sand Paper	20.17d	15.67e	0.48a
Control	15.30e	11.67e	0.47a

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Table 3: Correlation for growth parameters across the 8 treatments

	Plant height	Number of leaves	Number of branches
Plant height	1	0.97**	0.82**
Number of leaves		1	0.77*
Number of branches			1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

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Allelopathic Effect of Aqueous Extracts of *Lantana camara* L. on the Germination of Seeds and Growth of Seedlings of *Amaranthus cruentus* L.

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Abstract
Lantana camara (LC), a pantropic invasive weed, is fast becoming endemic in the lowland rainforest of Nigeria. It may interfere with other plants and inhibit crop performance by competition or allelopathy. This study aimed at determining the allelopathic and bioherbicidal potentials of its aqueous extracts. The effects of varying concentrations (0, 12.5, 25, 50 and 100%) of aqueous extracts of shoot and root of LC on germination of seeds and growth of seedlings of Amaranthuscruentus (AC) were determined in Ecology Laboratory and Screen house of Department of Crop Protection and Environmental Biology, University of Ibadan. Two (2) ml of each concentration was administered per petri dish containing 50 seeds of AC and 200 ml was administered per pot of seedling of AC, in completely randomized design with three replications. Germination (%), number of leaves (NLV), plant height (PH, cm/plant) and shoot dry weight (SDW, g/plant) were determined. The data were analysed by ANOVA, and significant means separated using Least Significant Difference (LSD) at 5% level of probability. The extracts significantly (P<0.05) reduced seed germination and seedling growth in AC. The mean germination was highest in control (91.0%) and least in S100 (26%). For NLV, PH and SDW were 22.00, 52.43 and 3.23,respectively. Similarly, at S100 16.00, 37.10 and 3.10 values were observed for NLV,PH and SDW, while at R100, the values obtained were 13.00, 37.10 and 1.98 respectively. The aqueous extracts of Lantana camara inhibited germination and growth of Amaranthuscruentus, suggesting its potential as abioherbicide.
Keywords: Invasive weed, Lantana camara, Bioherbicide, Aqueous extracts

INTRODUCTION

Lantana camara (big sage) belongs to the family Verbenaceae that is native to the American tropics (Moyhill, 2003). It has its spread from its native central and South America to about 50 different countries where it became an invasive species (Day, 2003). *Lantana camara* will often out-compete other more desirable species leading to reduction in biodiversity. It is toxic to livestock and its dense thickets can reduce farmland productivity.

Alleopathy encompass all types of chemical interactions among plants and microorganisms. Many organic compounds (allelochemicals) released from plants and microbes are known to affect the growth or aspects of functions of the receiving species (Stamp, 2003). Alleochemicals are important features characterizing the interrelationships among organisms. Allelopathy is tightly coupled with competition for resources and stress from disease, extreme temperatures and herbicides. These stresses often increase the production of allelochemicals and accentuate their actions. A number of secondary metabolites, phenolics, phenylalkanoic acids, hydroxanic acids, fattyacids, terpenes and glycosides were identified in extracts of *Lantana camara* (Rimando and Duke, 2003). These compounds are common in plants and some of them have a growth inhibitory activity against several plant species including weeds. Rice (1984) outlined the following factors which affect the amount of allelochemicals produced, and these are radiation, mineral deficiencies, water stress, temperature, allelopathic agents, age of plant organs, genetics, pathogens and predators.

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Lantana camara is an example of invasive weed species that interfere with native plants through allelopathy (Craig *et al*., 2011). Allelopathy may help in weed management (Zimdahl, 1987) through suppression of weed seed germination and seedling emergence by potential allelopathic species, suppression of weed growth through enhancing allelopathic potential of crops particularly in monoculture and use of plant residues and allelopathic crops in rotation and in intercropping systems.

Little is understood about the mechanism of spread of *Lantana camara*, therefore the study aimed at investigating the allelopathic potential of the water extracts of the root and shoot of *Lantana camara* on the germination of seeds and growth of *Amaranthuscruentus*.

MATERIALS AND METHODS

Experimental sites

The petri dish experiment was carried out in the Ecology laboratory while the pot experiment was done at the screen house of the department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan (Latitude 7°27.047' Longitude 3° 58.832', elevation of 214m above sea level (asl). Ibadan is in the low land rainforest-savanna transition ecological zone in the south western, Nigeria (Awodoyin*et al*., 2007).

Source of seeds

Seeds of *Amaranthuscruentus* were obtained from the Institute of Agriculture Research and Training (IAR&T) Moor plantation Ibadan, Nigeria. The fresh shoots and roots of *Lantana camara* were collected from the crop garden of the department of Crop Protection and Environmental Biology and the Practical Year Training Program of the Faculty of Agriculture, University of Ibadan.*Lantana camara* plant parts was partitioned into shoots and roots and dried at 40°C.

Soil analysis

The soil sample was collected with a soil auger from the department of Crop Protection and Environmental Biology crop garden and the routine analysis was done at the Department of Agronomy, University of Ibadan. The soil chemical analysis was done according to laboratory standard.

Preparation of aqueous extracts from dry shoot and root of *Lantana camara*

The extraction procedure was carried out according to the method of Ahn and Chung 2000. The shoots and roots of *Lantana camara* were cut into chips, ground with a grinding machine and soaked in 1L of distilled water for 12 hours and filtered through cheese cloth and whatman No 1 filter paper (9cm diameter). The final filtrates obtained from each plant part were considered as the stock solution. Other concentrations of the aqueous (50%,25% and 12.5%) were obtained using serial dilution with distilled water (equal v/v). The extract was stored in the refrigerator at 20°C to prevent putrefaction and degradation of the allelochemicals that may be present in them.

Seeds of *Amaranthuscruentus*were sterilized separately in 5% sodium hypochlorite for 90 seconds to prevent fungal infection after which they were rinsed for five minutes in water. The seeds were randomly selected and washed thoroughly in distilled water. Twenty seven petri dishes were sterilized using 5% sodium hypochlorite, rinsed and lined with whatman No 1 filter paper. The treatments were 12.5% shoot extract (SE), 25%SE, 50%SE, 100%SE, 12.5% root extract (RE), 25%RE, 50%RE, 100%RE.

Fifty seeds of the test crop were placed in each petri dish. The design was CRD with 3 replicates. The filter paper in each petri dish was replenished with 2 ml appropriate treatments daily to prevent drying out. The

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petri dishes were incubated at room temperature (27°C) for a period of 7 days while the number of seeds that germinated in each petri dish was counted and recorded.

Top soil was collected from the crop garden of the department of Crop Protection and Environmental Biology, University of Ibadan and filled into 30 bags. Each bag has a dimension of 13 x 11 cm and was perforated at the base each containing 4 kg soil.

Sterilized seeds of *Amaranthuscruentus* were sown and supplied with 200 mls of water daily for 2 weeks before transplanting at 2 seedlings per bag. Two hundred (200 mls) of the treatment were applied from three weeks.

The growth parameters taken were plant height using meter rule, number of leaves by visual counting and (Otusanya, 2007) dry weights of plant parts using top loading mettler balance (1210). The plants in the pots were lifted out and lowered into buckets filled with water to gently loosen the soil so that the roots can be fully recovered as much as possible.

Data analysis

The treatments were statistically compared using Analysis of Variance (ANOVA) following SAS (2000). Means were compared and separated using Least Significant Difference (LSD) at 5 % probability.

RESULTS

The result of the chemical analysis of the soil (Table 1) showed that the soil was neutral (pH 7.1) with low organic matter content (31.5%) and low nitrogen (2.15%). From the U.S.D.A. textural triangle, the soil was sandy loam.

Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on the germination of *A.cruentus* seeds

The result showed that as the concentration of root and shoot extracts increased, the germination of the seeds as expressed in percentages decreased in the first trial, also control (94.00$\pm$ 1.15%) was significantly ($p<$ 0.05) higher than all the treatments while R12.5 (76.00$\pm$ 1.15%) was also significantly ($p<$ 0.05%) higher than the treatments R50 (54.00$\pm$ 1.15%) and R100 (36.00$\pm$ 1.15%) (Table 2). There were no significant differences between treatment S50 (26.00$\pm$ 3.05% and S100 (22.00$\pm$ 1.15%) (Table 2). The same trend was observed during the second trial.

Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on number of leaves, plant heightand dry weights of *A.cruentus*

Plant height of both the dry shoot and dry root extract of the control seedlings of *A. cruentus* remained the highest in the experiment and was significantly different from their respective treatment.

The result also showed that as the concentration of shoot extract increased, the number of leaves reduced except for 5 and 6 WAS that increased and decreased respectively while as concentration of root extract increased, the number of leaves increased at 3 and 4WAS(Table 3). There was a reduction in the plant height while as the concentration of root extracts increased, plant height increased (Table 4). There was no significant difference among the treatments at the shoot extract concentration. As the concentrations of shoot extract increased:, shoot and dry weight increased while the concentrations of root extract increased, shoot and dry weight decreased(Table 5).

DISCUSSIONS

Studies that have been carried out on the colonizing plants of the Verbenaceae family, and it has been suggested that these plants could compete effectively and

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supress other plants in the same habitat as a result of their allelopathic activity or potential (Reigosa and Gonzalez, 2006). The extract from the dry shoot and dry root of *Lantana camara* had slight inhibitory effect on the germination of seeds of *Amaranthuscruentus*. Hussein *et al*,(2011) also showed that aqueous extracts of all plant parts of *Lantanacamara* have strong allelopathic effect on maize and finger millet.

Basically, the potential of the chemical compounds present in both the root and shoot of *Lantana camara*must have been responsible for the reduction in the germinated seeds. Otusanya*et al*. (2007) demonstrated that aqueous extract of root and shoot of *Tithoniadiversifolia* was inhibitory to the germination and growth of *A. cruentus* L.

Desalegn (2014), reported that *Lantana camara* leaf extracts had no significant ($p>0.07$) effect on seed germination of maize, tef and finger millet , but, at 75% extract concentration seed germination of tef was significantly reduced ($p<0.01$) by 13.5%.

The result is in line with that of Ann and Chung (2000), who found that aqueous extract of rice hull inhibited the shoot height of Barnyard grass (*Echinochloacrusgalli*). There was no distinct significant difference observed in the dry weight of *A. cruentus* at 6WAS except for the dry shoot and root extract at R100 when compared to its control. Huber *et al*. (2002) had earlier observed that exogenously applied phenolic acids reduced root and shoot dry weight of soybean. Sami and Jha (2016) reported that allelopathic effect of *Lantana camara* leaf extract on seedling growth of *Ciceraeritinum* indicated that higher concentration (75%) of the leaf extract have inhibitory effect on the seed germination.

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Table 1 Physicochemical properties of Experimental soil

Soil Properties		Values
pH		7.10
	Sand	72.00
Particle size (g/kg)	Clay	10.00
	Silt	18.00
	Ca	9.15
	Mg	0.54
Exchangeable bases (cmol/kg)	Na	0.40
	K	0.28
ECEC		12.40
% base sat		99.50
Organic C (g/kg)		3.15
Total N (g/kg)		0.21
Av P (mg/kg)		34.3
Textural class		Sandy loam

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Table 2: Effect of varying concentrations of aqueous extract of dry shoot and root of *Lantana camara* on germination of *Amarantuscruentus* seeds at 7 days after sowing (values shown are mean± SE, n=3)

Treatment	% Germination Trial 1	Trial 2
C00	94 ±1.15	88 ±1.15
S12.5	46±3.46	56±2.42
S25	40±1.15	46±3.46
S50	26±3.05	34±1.15
S100	22±1.15	30±3.05
R12.5	96±1.15	78±2.92
R25	76±1.15	76±1.15
R50	52±1.15	56±1.15
R100	36±1.15	44±1.15
LSD(0.05)	5.40	5.40

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

Table 3: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on number of leaves of *Amaranthuscruentus* (values shown are mean±SE, N=3)

Treatment	3WAS	4WAS	5WAS	6WAS
Control	9.67±1.08	11.67±0.82	19.67±0.82	22.00±0.82
S12.5	9.67±0.82	14.00±0.00	23.00±0.58	19.00±2.65
S25	8.67±1.08	12.00±0.00	19.00±2.45	12.00±2.82
S50	8.00±0.71	12.00±0.71	21.00±1.22	18.00±0.82
S100	11.00±1.87	11.00±0.00	17.00±0.82	16.00±4.14
R12.5	8.00±0.71	13.00±1.22	18.00±0.71	19.00±1.08
R25	9.00±0.41	14.00±0.71	19.00±0.71	19.00±0.82
R50	9.00±0.41	14.00±0.00	18.00±0.41	21.00±3.24
R100	10.00±0.71	14.00±0.41	19.00±0.82	13.00±2.55
LSD(0.05)	1.69	1.94	1.94	5.08

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

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Table 4: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on plant height (cm) of *Amaranthuscruentus* at 3,4,5 and 6WAS(values shown are mean±SE, N=3)

Treatment	3WAS	4WAS	5WAS	6WAS
Control	11.67±0.59	20.40±1.49	36.20±2.13	52.43±4.07
S12.5	11.73±0.94	22.83±1.76	38.20±4.35	49.76±5.83
S25	9.27±0.35	16.80±0.44	29.97±4.10	38.67±5.25
S50	9.17±0.29	17.60±1.42	34.43±0.66	47.33±1.24
S100	8.45±1.54	14.55±3.09	23.65±8.94	31.15±9.73
LSD(0.05)	1.89	3.54	7.89	10.73
Control	11.67± 0.59	20.40±1.49	36.20±2.13	52.43±4.07
R12.5	11.43±0.59	20.17±0.89	35.53±1.39	47.33±2.68
R25	9.97±2.66	23.07±1.93	36.37±3.03	47.77±4.59
R50	11.03±1.42	21.53±1.94	36.70±2.43	49.10±2.39
R100	10.97±0.94	19.27±1.06	33.93±0.43	37.10±3.18
LSD(0.05)	3.76	3.92	5.36	8.93

Where S12.5,S25, S50 and S100 =12.5,25,50 and 100% concentration of aqueous extract of shoot
R12.5, R25 ,R50 and R100 = 12.5,25,50 and 100% concentration of aqueous extract of root

Table 5: Effect of varying concentrations of aqueous extracts of dry shoot and root of *Lantana camara* on dry weight (mg/g) of *Amaranthuscruentus* after 6WAS(values shown are mean±SE, N=3)

Treatment	Dry shoot	Dry root
C00	3.23±0.76	0.57±0.13
S12.5	2.02±0.35	0.47±0.67
S25	2.51±0.43	0.56±0.02
S50	2.39±1.01	0.45±0.19
S100	3.10±0.37	0.81±0.12
LSD(0.05)	NS	NS
C00	2.95± 0.05	0.96±0.54
R12.5	2.55±0.26	0.57±0.22
R25	1.80±0.17	0.66±0.17
R50	1.46±0.36	0.39±0.60
R100	1.37±0.15	0.34±0.05

Assessment of Root Yield and Yield Attributes of Improved Orange Fleshed Sweet Potato (*Ipomoea batatas* (L.) Lam) Varieties in Sudan Savannah of Nigeria

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Abstract

Initiatives have spawned to encourage the production and consumption of orange-fleshed sweet potato varieties that are rich in beta-carotene and help fight vitamin A deficiencies. In Nigeria, most of the sweet potato landraces have white-fleshed roots with negligible amounts of beta-carotene. Therefore research was carried out in two locations (Garko and Madobi) local government areas of Kano state Sudan savannah agro-ecology of of Nigeria during 2016 rainy season, aimed to evaluate a newly introduced improved orange fleshed sweet potato varieties for possible recommendation to local farmers in the study areas in order to enhance its production and consumption. The experiment consisted of four improved varieties and one local variety (Check) which were laid in randomized completely block design with three replications. Data gathered were subjected to analysis of variance using Genstat statistical software and means were separated using Duncan multiple range test (DMRT) at 5% level of probability. The result revealed significant differences among the varieties in all the yield and yield attributes except number of pencil roots. The local check out yielded the introduced orange fleshed varieties but some of the improved orange fleshed varieties (T121 and King J) recorded significantly higher average root weight, root diameter and commercial index thus indicating ability to compete with the local variety. Despite significantly higher total (26 t ha^{-1}) and marketable (20 t ha^{-1}) yield of the local check. King J and T121 with total yield of 19.5 and 14.6 t ha^{-1} respectively, and marketable yield (15.3 and 13.5 t ha^{-1} respectively) can be considered as promising varieties in the study area to boost production of orange fleshed sweet potatoes. Madobi was found to be the location significantly higher in all the yield and yield attributes evaluated except number of pencil, damaged and non-marketable root per plant. It can be established that King J and T121 will contribute toward production and consumption of vitamin A rich diet to the vulnerable people in the study areas.

Key words: Vitamin A, sweet potato, assessment and yield

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam.) is a dicotyledonous plant which belongs to the family Convolvulaceae. It is an important root crop for food security, cultivated in over 100 developing countries and ranks among the five most important food crops in more than 50 of those countries. Over 95% of the global sweet potato production is in developing countries (Ali *et al*., 2015). The production, marketing and utilization of sweet potato have expanded in the last decade to almost all ecological zones of Nigeria. In 2010 Nigeria produced 2.5% of the world's production of sweet potato and ranked the 10th the highest production level than any single food crop with gross agricultural production valued at $954 US Dollars which accounted for 1.73% of total agricultural production of all crops (Leigh, 2012). Vitamin A deficiency (VAD) has far reaching consequences and

is one of the three most common deficiencies in the world and in sub-Saharan Africa. The VAD contributes up to 25% of child mortality due to related diseases such as malaria, diarrhoea associated diseases, acute respiratory infections and vaccine preventable diseases. It can cause retarded growth and development, causing slow progress at school children, night blindness and even total blindness, susceptibility to diseases and in severe cases death. The elderly, children, pregnant and lactating women are the most affected. Beta-carotene-rich sweet potato (also known as orange-fleshed

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sweet potato) is one of a few new crops, which is both an excellent source of energy and important nutritive substances that can contribute to improve the nutrient status of communities. This was why the crop is being promoted by various organizations in Sub-Saharan Africa (CIP, 1999). Considering the potentiality of the crop in alleviating hunger and malnutrition, there is a need for identifying varieties suited to specific agro-ecological conditions. Therefore this research was conducted to investigate yield potential of orange fleshed sweet potato varieties for possible recommendation to farmers toward increasing yield and alleviation of vitamin A deficiency and other malnutrition problems especially in the vulnerable rural communities of Nigeria.

MATERIALS AND METHODS

Field experiments were conducted during the rainy season (July-October) at two locations namely; Garko ($11^0$39'N $8^0$54'E) and Madobi ($11^0$46'38"N $8^0$17'18"E) Local Government Areas of Kano State in Sudan Savannah agro-ecology of Nigeria. The treatments were 4 orange fleshed sweet potato varieties; Gloria, King J, Melinda , T121 and one local variety (Danchina).. The design of the experiment was randomized completely block design with three replications. Each plot measured 3m x 3m (9m^2)consisted of 4 ridges spaced at 0.75m,the 2 inner rows where reserved as net plots (4.5m^2) for data collection.

The lands were manually cleared, harrowed to fine tilth and ridges of 75cm apart were constructed in each plot. Sweet potato vine cuttings of at least 30cm length with at least 3 buds were used for planting. Supplying was done at 2 weeks after planting. The planted vine cuttings were spaced at intra row spacing of 30 cm and inter row spacing of 75 cm. NPK 15:15:15 fertilizer was applied at 3 weeks after planting at rate of 400 kg ha^{-1} to all plots. Hoe weeding was carried out at 4 and 8 weeks after planting. The vines periodically lifted carefully and hilling-up was done by hoeing up the soil around the base of the plant to ensure the developing storage roots are well covered and not exposed to sun and attack by weevils. Insect pests were controlled by spraying with Optimal 20 SP and Cypermetrin at the rates of 250g ai ha-^{1} and 1.0 l ai ha^{-1}respectively.Harvesting was carried out after attainment of physiological maturity(100-120 days) when 90% of the plant leaves in a plot turned yellow and by cracking of the soil. The mature roots were dug up manually with hoe.

Data on yield attributes collected from 4 tagged plants in the net plots included number of marketable roots (greater or equal to 100 g) and non-marketable roots (less than 100 g) (Lavette,1993).The number of pencil root (lignified root), damaged roots, root length(determined by measuring length of the storage roots using calibrated ruler) and root diameter (measured at the widest point in the middle portion of the storage roots using Digital calipher-150 mm). Harvested storage roots were weighed using metlar electronic balance (Model MT: 2000). The yields were calculated from the storage roots in net plot and extrapolated to yield per hectare using the formula: -

Yield (t ha^1)

$$= \frac{\text{Weight of roots in net plot(kg)}}{\text{Area of the net plot } m^2} \times \frac{10000\, m^2}{1000}$$

Commercial index which is the ratio of marketable yield to the total yield was also calculated. Data gathered were subjected to analysis of variance using Genstat 17th edition statistical software package and means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability.

Pre-planting soil samples were collected from the experimental fields using soil auger at depth of (0-30 cm) and analysed

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for physical and chemical properties as described by Black(1965). Data on monthly rainfall of the experimental sites during the period of the study were obtained and recorded from Kano Agriculture and Rural Development Authority.

RESULTS AND DISCUSSION

Yield and yield attributes of sweet potato varieties

The results of yield and yield characters in this study revealed that almost all the yield and yield contributing characters varied significantly among the varieties (Table 3 and 4). These differences may be due to genetic differences since all the introduced varieties as well as the check received equal management. Huaman*et al*. (1999) reported that yield and yield attributes are highly controlled by genetic constitution and are genetically inherited. The local check (Danchina), T121 and King J produced significantly higher marketable and total yield which could be attributed to the higher average root weight and number of marketable roots (Table4) than the other varieties. According to Mesenbet (2015), the variation among sweet potato varieties for root yield might be ascribed to the genetic potential differences in producing number of storage roots and weight of the storage roots. King J and T121 were found to be significantly higher than the local check in yield contributing characters (average root weight and diameter Table 4) but still the local variety produces higher marketable and total yield. This could be to do the ability of the local check to produce higher number of storage root (Table 3), thus indicating usefulness of number of roots in determining yield of sweet potato than other yield attributes. Gasura*et al*., 2008 also reported that root yield depends on the number of storage roots per plant. These results are consistent with Ssebuliba*et al*. (2006) who reported higher number of root per plants for local accessions compared to introduced orange-fleshed sweet potato varieties. The total root yield for the local variety was generally higher than the introduced varieties. This may be attributable to the adaptability of the local varieties to the local environment.

Effect of location on yield and yield attributes of sweet potato

There were significant differences in root and root yield characters between the locations.These differences could be due to soil and rainfall during the period of the studies.The low marketable and total yield recorded at Garko could be related to low Potassium content of its soil compared to Madobi that have high potassium content as shown in Table 1. This was in consonance with the findings of Isiaka, 2013 that the yield of sweet potato is depressed if potassium is missing. George *et al*. (2002) also reported that potassium influence tuber yield via an increase in the proportion of dry matter diverted to the tuber. It is widely known that sweet potato requires high potassium contents in the soil to promote tuber formation and development. Similarly, Garko recorded very low total rainfall (368.3 mm) compared to Madobi (523.6 mm) (Table 2) which might have affected the yield. Ngailo*et al*. (2013) reported that unfavourable weather conditions reduce root yield. The higher yield obtained at Madobi than Garko could also be due to textural class of the soil (sandy loam), compared with loamy sand of Garko (Table 1) as sweet potato does well on sandy loam soil. Brandenberger*et al*., 2010 reported that sandy loam soils are the best for growing sweet potato. The significant higher number of pencil roots per plant recorded in Garko (Table 3) could be attributed to low rainfall (table 2). This confirmed the statement of Stathers*et al*., 2013 that unfavourable condition during root initiation such as drought caused

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formation of pencil roots instead of storage roots. The significantly higher number of damaged roots per plant at Garko (Table 3) could also be attributed to low rainfall as the root damaged was predominantly caused by weevil which according to Kokorum*et al*. (1992) ,weevil attack on roots of sweet potato is more severe in dry soils.

CONCLUSION

The high yield and yield contributing characters of King J and T121 enable them to be promising adaptable orange fleshed sweet potato varieties in the study area that could be used for increased production and consumption. The significant higher commercial index of T121 than the local check indicates it could be selected for commercial production to increased farmers income in Kano state.

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Table1. Soil Physico-Chemical Properties of the Experimental Sites.

Soil properties	Garko	Madobi
Particle size distribution (%)		
Sand	87.60	59.60
Silt	5.28	31.28
Clay	7.12	9.12
Textural class	Loamy sand	Sandy loam
Chemical properties		
pH (H_2O)	5.96	5.77
EC (ds/m)	0.03	0.03
Organic carbon (gkg^{-1})	1.00	2.20
Nitrogen (gkg^{-1})	2.50	0.70
P (mg/kg)	12.98	11.25
Ca^{++} (Cmol/ kg)	2.19	2.56
Mg^{++} (Cmol/ kg)	1.87	1.13
K^{+} (Cmol/ kg)	0.22	0.42
Na^{+} (Cmol/ kg)	0.13	0.27
CEC (Cmol/ kg)	5.08	4.88

Table 2. Rainfall During the Experimental Period

Month	Garko	Madobi
July	201.9	157.1
August	162.8	240.3
September	3.90	116.2
October	NIL	10.4
Total	368.3	523.6

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Table 3. Effect of Varieties and Location on Number of Pencil, Marketable, Damaged Roots, Non-Marketable and Total Storage Roots per Plant of Sweet Potato.

Treatment	Number of pencil roots per plant	Number of damaged roots per plant	Number of marketable roots per plant	Number of non-marketable roots per plant	Total number of storage roots per plant
Varieties					
Gloria	1.56	0.63a	0.44e	2.06b	2.50b
King J	1.81	0.65a	1.63b	1.00d	2.63b
Melinda	1.76	0.31b	0.63d	1.50c	2.13c
T121	1.66	0.13c	1.00c	0.88e	1.88c
Danchina (Local)	1.69	0.44b	1.88a	2.44a	4.31a
Level of Significant	NS	**	**	**	**
SE±	0.945	0.073	0.064	0.055	0.124
Location					
Garko	2.48a	0.55a	0.90b	1.50b	2.40b Madobi
	0.91b	0.30b	1.33a	1.65a	2.98a
Level of significant	*	**	*	*	**
SE±	0.598	0.046	0.038	0.087	0.079

Means followed with the same letter in the same column are not significantly different at 5% level of probability using DMRT, NS= Not significant,*=significant and **= highly significant

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Table 4. Effect of Varieties and Location on Average Root Weight (g), Root Diameter (cm), Root Length (cm), Yields (t ha^{-1}) and Commercial Index of Sweet Potato.

	*Av.Rt (g)	Rt. Di. (cm)	Rt. Lgt. (cm)	Yield (t ha^{-1})	Wt. Rt. (g)	Mkt.	Non-Mkt
Treatment							
Varieties							
Gloria	40.9e	3.0e	12.8a	1.0e	2.0c	3.0d	0.3d
King J	149.0a	9.7a	12.4ab	15.3b	4.2b	19.5b	0.8b
Melinda	49.0d	6.0c	8.1d	2.1d	1.4d	3.5d	0.6c
T121	133.6b	7.8b	11.9b	13.5c	0.9e	14.4c	0.9a
Danchina (Local)	121.2c	5.7d	9.7c	20.6a	5.4a	26.0a	8b
Level of Significant	**	**	**	**	**	**	**
SE±	0.90	0.06	0.31	0.19	0.10	0.20	0.03
Location							
Garko	66.2b	6.3b	10.6b	5.7b	3.1a	8.7b	0.6b
Madobi	131.3a	6.6a	11.2a	15.3a	2.4b	17.6a	0.8a
Level of significant	**	**	*	**	**	**	**
SE±	0.57	0.04	0.20	0.12	0.06	0.13	0.02

Means followed with the same letter in the same column are not significantly different at 5% level of probability using DMRT, *=Significant and **= highly significant.
*Av.Rt= Average Root, Rt. Di.= Root Diameter, Rt.Lgt.= Root Length,Wt.Rt.=Weight Root, Mkt= Marketable, Non-Mkt= Non marketable

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Varietal Response of Tomato (*Solanum lycopersicon*) to Transplanting at Different Seedling Age

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Abstract
Field trial was conducted at the experimental field of National Horticultural Research Institute, Ibadan, Nigeria to assess the response to transplanting at different seedling ages on growth and yield of four selected tomato varieties. The treatments consisted of four seedling ages (2, 3, 4 and 5 weeks after sowing) and four tomato varieties- Tropimech (V1), Alahausa (V2), Cobra (V3) and Roma VF(V4). The trial was a 4 x 4 factorial laid out in a randomized complete block design and replicated three times. Data were collected on growth and yield parameters and analyzed using analysis of variance (ANOVA) and treatment means compared with least significant difference at 5% probability level. The results showed that the highest plant height was obtained from Tropimech tomato variety (52.43cm) at 5weeks seedling age. The highest dry matter and fruit weight was obtained from Alahausa tomato variety at 4weeks seedling age. Therefore, Alahausa tomato variety transplanted at 4weeks seedling age gave the highest fruit weight which is a good index for yield output for further research.

INTRODUCTION

Tomato (*Solanum lycopersicum*) is one of the most important vegetables worldwide belonging to the *Solanaceae* family. It is grown outdoors or indoors because of its wide adaptability and versatility. In Nigeria, tomato crops are grown during both the wet and dry seasons although they attract higher profits during the dry season when the demand is higher than the supply (Olaniyi, 2007). Tomato fruit contains lycopene, an antioxidant compound that reduces the risk of cancer (Miller *et al*., 2002). The fruits are eaten raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder (Olaniyi and Ajibola, 2008).The average yield of tomato in Nigeria is about 7.0 t/ha (FAOSTAT, 2005) where, it is widely cultivated in guinea savanna throughout the year using irrigation facilities. Tomato production at a given location depends on the potential of the genotype used and timely availability of resources (Isah *et al.,* 2014). Farmers in Nigeria obtained very low yield (7 t/ha) compared to global yields, that could be attributed to cultural practices adopted by the farmer (FAOSTAT, 2005).

Tomato growers in the tomato industry have mostly been found to possess inadequate or lack of knowledge on improved agronomic practices and production techniques such as seedling age before transplanting and cropping pattern, which place higher constraints on tomato production (Grassbaugh and Bennett, 1998). It is therefore necessary to determine the effect of seedling age on tomato varieties commonly grown in south western Nigeria.

MATERIALS AND METHOD

The field trial was carried out during the April – July rainy season of 2016 at the experimental field of the National Horticultural Research Institute, Ibadan located in the forest savanna zone of south–west Nigeria with Latitude 7^{O} 23' and 7^{o} 25'N and longitude 3^{o} 50' and 3^{o} 52'E. The treatment consisted of four varieties of tomato namely: *Tropimech* (V1), *Alahausa* (V2), *Cobra* (V3), and *Roma VF* (V4) and four seedling ages before transplanting. Tomato varieties were sown in the nursery at the Institute screen house in trays filled with sterilized top soil.

The seedlings were later transplanted at 2, 3, 4 and 5 weeks after sowing (WAS) into a well-drained raised seedbed of 2 x 2m at a spacing of 50 x 50cm per plant on a plot. The 4 x 4 factorial combination of the treatments were arranged in randomized complete block design with three replicates. Organic manures were used during planting and pests were controlled using plants extracts such as onion extract, neem extract and pepper spray at 1000ml/15litres of water; all at different stages of tomato growth. Data were collected on plant height (cm), number of leaves (count), stem girth (cm), leaf area (cm^2), plant dry matter and fruit weight (g). All data generated were subjected to statistical analysis of variance (ANOVA) using (Genstat 7.2 Discovery Edition 3, 2007) and significant means separated using least significant difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

The plant height of tomato increased gradually with the plant age. The interaction of tomato variety and seedling age was significant ($P<0.01$) at 10 and 13 WAS respectively. The results reveal in Table 1 that *Tropimech* (V1) transplanted at 5weeks seedling age (S1) gave the tallest plant (52.43cm) while the shortest plant height(12.07cm) was recorded from *Cobra* (V3) transplanted at 2weeks seedling age (S4).This observation was in line with (Orzolek, 2004) and Schrader (2000) who reported that vegetables transplanted at their older age develop faster. The interaction of tomato variety and seedling age had no significant on stem girth at 10 and 13 WAS. *Alahausa* (V2) at 2weeks seedling age (S4) produced the widest stem of 1.82cm while the least value of stem girth (0.18cm) was obtained from Roma VF (V4) at 5weeks seedling age(S1) (Table 1). The number of leaves increased gradually with the increase in plant age. The interaction of tomato variety and seedling age was significant ($P<0.05$) at 10WAS while no significant effect was observed at 13WAS. The highest number of leaves (11.10) were obtained with *Alahausa*(V2) at 4weeks seedling age (S2) while the least number of leaves (2.83) were obtained from *Tropimech*(V1) at 5weeks seedling age (S1). The leaf area increased gradually with the increase in plant age. The interaction of tomato variety and seedling age had no significant effect at 10WAS while significant ($P<0.05$) effect was observed at 13WAS (Table 1).The highest leaf area (423cm^2) was obtained from *Roma VF* (V4) at 4weeks seedling age(S2) while the least leaf area (43cm^2) was obtained from *Roma VF* (V4) at 5weeks seedling age(S1). From Figure 1, plant dry matter yield(g/plant) were shown, it was observed that *Tropimech* at 4 weeks seedling age (V1S2) had the highest dry matter while *Alahausa* at 5weeks seedling age (V2S1) had the lowest dry matter yield. From figure 2 , it was observed that *Alahausa* at 4weeks seedling age (V2S2) had the highest fruit weight among all the treatment which is in line with the findings of Ademiluyi (2011), who recommended that plants with better growth rate were obtained at seedling age at 4weeks after sowing. Also, NIHORT (2016), reported that tomato can be transplanted between 4-5 weeks after sowing. V2S3 was the next in fruit weight to V2S2 while V4S3 shows the lowest fruit weight (Fig.2).

In conclusion, Alahausa tomato variety at 4weeks seedling age gave the highest fruit weight which is a good index for yield output for further research.

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Table 1: Effect of growth parameter on seedling age of tomato varieties.

		Plant height(cm)		Stem girth(cm)		Leaf area(cm^2)		Number of leaf	
		Weeks After Sowing(WAS)							
Variety	**Seedling Age(weeks)**	10	13	10	13	10	13	10	13
V1	S1	41.18	52.43	1.31	1.63	115.5	398	7.67	7.83
	S2	38.65	39.25	1.28	1.56	93.7	309	8.28	10.17
	S3	30.83	32.84	1.10	1.12	52.0	253	6.78	7.87
	S4	30.30	34.60	1.31	1.61	88.1	310	6.38	6.73
V2	S1	16.37	30.05	0.75	1.32	47.5	140	4.15	5.22
	S2	40.42	43.78	0.94	1.57	115.9	371	10.90	11.10
	S3	32.43	40.43	0.98	1.79	100.2	357	7.33	7.58
	S4	30.65	33.23	1.12	1.82	102.3	300	6.72	7.15
V3	S1	17.48	35.53	1.06	1.17	32.9	243	4.68	5.58
	S2	31.58	38.73	0.94	1.31	69.5	322	7.50	9.42
	S3	22.28	36.12	1.12	0.72	57.9	264	5.02	5.45
	S4	10.63	12.07	0.87	1.28	69.0	322	5.57	6.55
V4	S1	21.09	40.02	0.56	0.18	9.2	43	2.47	2.83
	S2	21.09	40.02	0.64	0.91	74.5	423	6.27	6.60
	S3	20.10	35.52	0.54	0.94	60.3	330	5.22	5.63
	S4	19.14	32.02	0.64	0.86	68.2	416	5.68	6.12
Significant		**	**	NS	NS	NS	*	*	NS
L.S.D.$_{0.05}$		8.83	29.11	0.73	1.74	64.62	216.2	2.73	3.27

NB: V1=Tropimech, V2= Alahausa, V3= Cobra, V4=Roma VF S1= 5weeks, S2= 4weeks, S3= 3weeks, S4= 2weeks

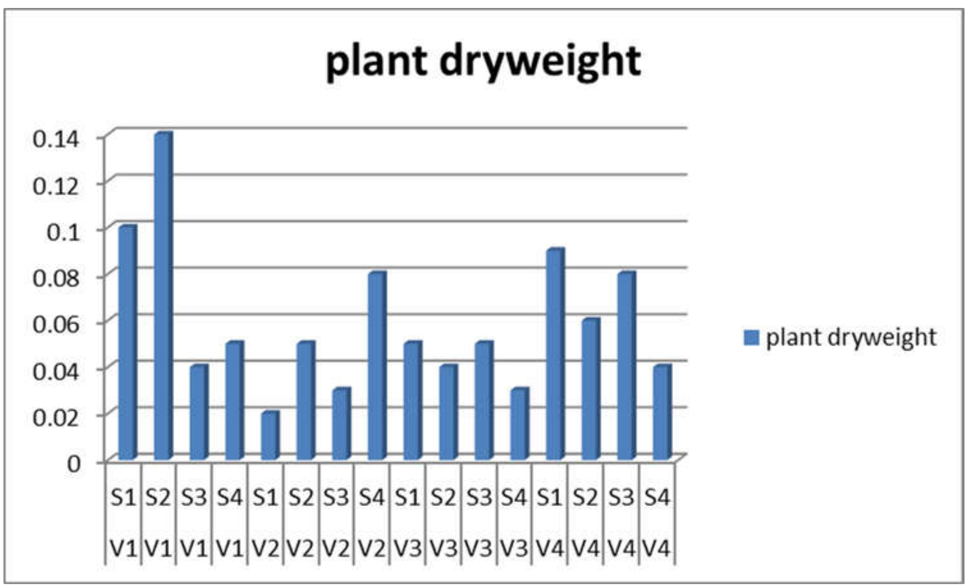

Fig. 1: **Effect of seedling age on dry matter yield of tomato varieties.**

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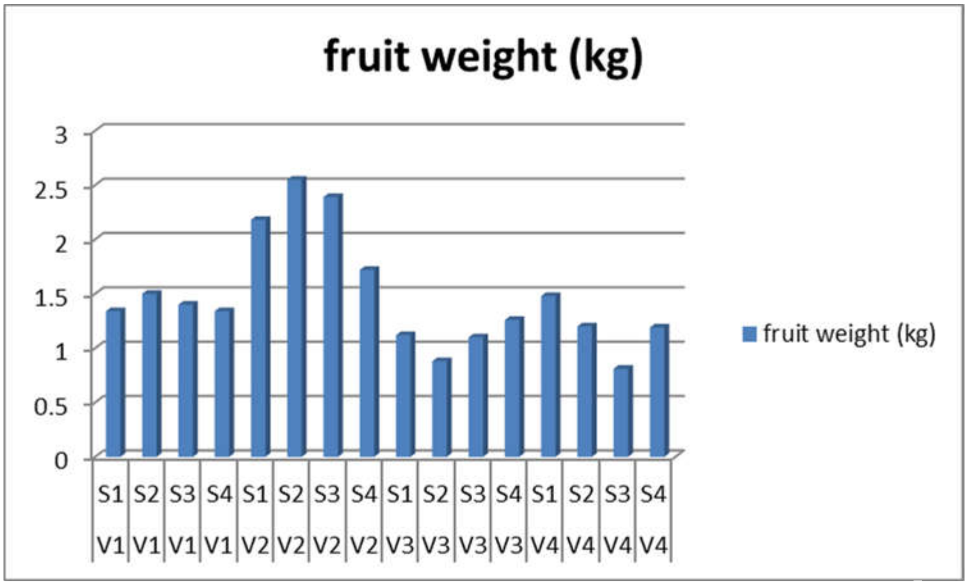

Figure 2: Effect of seedling age on fruit weight varieties of tomato.

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Growth and Yield of three Varieties of Tomato as Influenced by Staking and Spacing

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Abstract
A field experiment was conducted between May and August, 2016 at the National Horticultural Research Institute (NIHORT), Ibadan to determine varietal performance of staked and unstaked tomato at different spacing. The study was a 3x2x3 split-split-plot experiment fitted into randomized complete block design (RCBD) with four replications. Three varieties of tomato (UC82B, Tropimech and Ibadan Local) were the main-plot, staking (staking and no staking) served as the sub-plot and the sub-sub-plots were three different spacing (60cm x 30cm, 60cm x 45cm and 60cm x 60cm). Growth and yield data collected were subjected to analysis of variance (ANOVA) and significant means were compared using the least significant difference (LSD). The results indicated that Ibadan local was significantly shorter compared to UC82B and Tropimech but produced significantly higher number of leaves and branches. Unstaked tomato produced significantly higher number of leaves compared to staked tomato but average fruit weight and marketable fruit weight of staked tomato was significantly higher than unstaked tomato. Tomato planted at 60cm x 60cm produced fruits with significantly higher average weight of 49 g than those planted at 60cm x 45cm (43.7g) and 60cm x 30cm (43. 6g). On the other hand, fruit weight and fruit yield of tomato planted at 60cm x 30cm was significantly higher than those planted at 60cm x 45cm and 60cm x 30cm. It could therefore be concluded that Ibadan local produced the highest fruit yield, likewise staked tomato produced more fruit yield and tomato planted at 60cm x 30cm produced more fruit yield.
Keywords: *fruit yield, Spacing, Staking, Tomato, varieties.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L. Miller) is an economically important crop worldwide. It belongs to the family *Solanaceae* and it's a native of Peru Ecuador region (Jenkins, 1948). It is normally a self-pollinated crop. It ranks 16th among vegetables in relative concentration of vitamins and minerals and most highly priced and consumed widely. Tomatoes are rich sources of vitamins A and C, potassium and fiber. They are rich in lycopene (Dimascio *et al.,* 1989; Trinklein, 2010). Yield and quality of tomato could be improved through the use of improved crop cultural practices. Trinklein (2010) showed that proper spacing and staking are essential for healthy plants and good fruit production. Tomato variety is classified according to growth type (determinate and indeterminate), determinate varieties do not require stake as the indeterminate varieties because they continue to grow and produce fruit year round except they are killed by the harsh weather (Hanson *et al.,* 2000). It is necessary for indeterminate

variety to be supported with local material such as woods or bamboo that can be afforded by both small and large scale farmers. Staking is a means of providing supports to ensure clean and unblemished fruits which kept fruits off from the ground, minimizing diseases and rotting of fruits thereby increasing marketable yield. Staking improves marketable yield, fruit set and fruit quality and also makes harvesting easier, staked plants are less likely than unstaked plants to get diseases. Akoroda *et al.* (1990) and Trenbath (1976) supported the idea of staking because it facilitates harvesting of vegetable and pods and also exposes the leaves for effective light reception. Spacing affects growth, yield and quality of tomatoes

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as well as pest and disease prevalence. Spacing is among the management practices which greatly influence tomato fruit yield (Lemma *et al.,* 1992; Mehla *et al.,* 2000; Abdel-Mawgoud *et al.,* 2007). Appropriate spacing can help to mitigate attack from disease and to obtain early or delayed harvest depending on the demand and market price. Appropriate spacing can also help to obtain early or delayed harvest depending on the demand and market price, wider spacing (60 cm X 50 cm) gave higher marketable yield (82.39 t/ha) than closer spacing of 60 cm x 40 cm (Ara *et al.,* 2007). Wider spacing minimizes competition for nutrients, water and radiation (Wasserman, 1985; Cochlar and Joseph, 1986). Muhammad and Singh (2007) further showed that greater circulation of air and interception of light by plants resulting in lower incidence of diseases and pests at wider spacing. Appropriate spacing is however in relation to variety, soil fertilization and other cultural practices, including season of production. Proper spacing is also crucial to allow light penetration to the lower leaves of the plants. The aim of this experiment was therefore to determine the varietal performance of staked and unstaked tomato at different spacing.

MATERIALS AND METHODS

The study was conducted between May and August, 2016 at the Vegetable Research field of National Horticultural Research Institute (NIHORT), Ibadan, Nigeria ($7^0 23^1$N and $3^0 54^1$E 168 m a.s.l.), located in the forest agro-ecological zone of Nigeria with bi-modal rainfall pattern. The study was a 3 x 2 x 3 split-split-plot experiment fitted into randomized complete block design (RCBD) with four replications. Three varieties of tomato (UC82B, Tropimech and Ibadan Local) were the main-plot while staking (staking and no staking) served as the sub-plot and the sub-sub-plots were three different spacings which included 60 cm x 30 cm, 60 cm x 45 cm and 60 cm x 60 cm corresponding to 55,555, 37,037 and 27,777 plants per hectare respectively.

Land preparation was done mechanically by ploughing, harrowing and bedding. Seeds of tomato obtained from NIHORT and commercial seed store were sown in the nursery on 7th April, 2016 and transplanted on 5th May, 2016 at different spacing based on the treatment. The plot size was 5 m x 0.6 m (3 m^2). Hand weeding was done three times using hoe at 3, 6 and 9 weeks after transplanting (WAT). NPK 15-15-15 was applied at the rate of 120 kgN/ha, this was applied 3 WAT. Data collected on plant height, number of leaves, number of branches, leaf length, number of fruit/plant, fruit weight/plant, and fruit yield/ha were subjected to analysis of variance (ANOVA) using the SAS programme (SAS, 1990). Significant means were compared using the least significant difference (LSD) at 5% probability level

RESULTS AND DISCUSSION

Tomato production is difficult in an open field under rain fed condition, employing appropriate field and disease management practices such as the use of spacing, pruning, staking, ridging, fertilization along with tolerant varieties can however help to produce tomatoes under rain fed (Dessie and Dejen, 2015). Yield and quality of tomato could be improved through the use of improved crop cultural practices. Trinklein (2010) showed that proper spacing and staking are essential for healthy plants and good fruit production. Results from this study indicated that no significant difference existed between UC82B and Tropimech varieties of tomato in terms of plant height and leaf length while Ibadan local was significantly shorter in terms of height and

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leaf length (Table 1). This may be attributed to the fact the varieties used were determinate type which cease growth at the onset of reproductive phase. This finding corroborated that of Hanson *et al.,* 2000 who opined that determinate varieties do not require stake as the indeterminate varieties because they continue to grow and produce fruit year round except they are killed by the harsh weather. Ibadan local produced significantly higher number of leaves compared to branches than UC82B and Tropimech while the later were comparable with each other in terms of number of leaves but UC82B produced significantly higher number of branches compared to Tropimech (Table 1).

Staking had no significant effect on plant height and number of branches of tomato, whereas unstaked tomato produced significantly higher number of leaves and longer leaves compared to staked tomato (Table 1). This could be due to the fact that the tomato varieties planted were determinate plant which stopped growing upon reaching reproductive stage and this made the staked plant not to be significantly taller than unstaked ones. Spacing significantly affected plant height, number of leaves and leaf length of tomato. Tomato planted at 60 cm x 30 cm produced significantly taller plants with significantly higher number of leaves and longer leaves while tomato planted at 60 cm x 45 cm and 60 cm x 60 cm were comparable with each other in terms of plant height, number of leaves, number of branches and leaf length (Table 1). This could probably be due to the fact that inter plant competition among tomato planted at closer spacing was high to the extent that they struggled to reach for sunlight there by making the plants to grow taller than those planted at wider spacing.

From this study, Ibadan local produced significantly higher average fruit weight (48.75 g), marketable (5.71 t/ha) and unmarketable (2.41 t/ha) and total fruit yield (8.12 t/ha) but unmarketable fruit weight produced by UC82B (1.98 t/ha) was comparable with that of Ibadan local (Table 2). This study also revealed that staking significantly affected average fruit weight and marketable fruit weight of tomato, average fruit weight and marketable fruit weight of staked tomato was significantly higher than unstaked tomato while unmarketable fruit weight and total fruit yield were not significantly affected by staking (Table 2). This may be due to the fact that staked tomato were properly exposed to sunlight for photosynthesis unlike the unstaked plants that intra-plant competition may restrict access to sunlight thereby reducing the amount of sunlight intercepted by the plants. This is in accordance with the work of Dessie and Dejen (2015) that staking improves marketable yield, fruit set and fruit quality and also makes harvesting easier. Staked plants are less likely than unstaked plants to get diseases.

Yield and fruit size of tomatoes are influenced by many factors, including plant spacing and pruning (Jeanine and Edmund, 1993). Spacing is among the practices to improve yield and quality and critical for disease development and dissemination. Spacing affects growth, yield and quality of tomatoes as well as pest and disease prevalence (Dessie and Dejen, 2015). According to Abdel-Mawgoud *et al* (2007), spacing is among the management practices which greatly influence tomato fruit yield. Lemma *et al* (1992) also reported that plant spacing greatly influenced fruit yield in both fresh market and processed tomatoes. Likewise, Godfrey-Sam-Aggrey *et al* (1985)

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and Mehla *et al* (2000) reported that yield parameters in tomato have been highly influenced by spacing. Results from this study indicated that spacing significantly affected fruit yield and average fruit weight of tomato, tomato planted at wider spacing (60 cm x 60) cm produced fruits with significantly higher average weight of 49 g than those planted at 60 cm x 45 cm (43.7 g) and 60 cm x 30 cm (43. 6 g) which were comparable with each other (Table 2). This may be due to the fact wider spacing minimizes inter-plant competition for nutrients, water and radiation as reported by Wasserman (1985); Cochlar and Joseph (1986). Muhammad and Singh (2007) further showed that greater circulation of air and interception of light by plants resulting in lower incidence of diseases and pests at wider spacing. On the other hand, fruit weight (i.e. marketable and unmarketable) and fruit yield of tomato planted at 60 cm x 30 cm was significantly higher than those planted at 60 cm x 45 cm and 60 cm x 30 cm which were not significantly different from each other (Table 2). This could be due to higher plant population per plot at closer spacing than at wider spacing as reported by Jia (1992). Moreover, closer spacing, according to Mbinga (1983) might have enabled maximized use of the applied nutrients better than the wider spacing.

CONCLUSION

Among the three varieties of tomato used in this study, Ibadan local produced the highest fruit yield, likewise staked tomato produced more fruit yield than unstaked tomato and tomato planted at closer spacing (60 cm x 30 cm) produced more fruit yield than those planted at other spacing. It could therefore be recommended that for optimum yield, tomato should be staked and planted at spacing of 60 cm x 30 cm.

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Table 1: Growth Parameter of three tomato varieties as affected by staking and spacing

Treatment	Plant height (cm)	Number of leaves	Number of branches	Leaf length (cm)
Variety				
UC82B	53.89	20.97	4.93	27.94
Tropimech	52.79	21.32	3.83	26.81
Ibadan local	45.00	26.82	5.54	24.57
LSD	2.35	1.94	0.39	1.72
Staking				
Staked	50.41	22.00	4.71	25.90
Unstaked	50.40	24.07	4.81	27.03
LSD	1.92	1.58	0.32	1.40
Spacing				
60 cm x 30 cm	54.32	24.80	4.93	27.71
60 cm x 45 cm	48.62	21.91	4.52	25.70
60 cm x 60 cm	48.72	22.40	4.83	25.93
LSD	2.35	1.94	0.39	1.72
F Sig. ($P \leq 0.05$)				
Variety (V)	**	**	**	**
Staking (St)	ns	*	ns	Ns
Spacing (Sp)	**	**	ns	*
V × St	ns	*	**	Ns
V × Sp	**	**	ns	Ns
St × Sp	ns	ns	*	Ns
V × St × Sp	ns	**	ns	Ns

*,** indicate significance effect of the treatment at 5% and 1% probability level.
ns mean not significant
V means variety, St means Staking while Sp means Spacing

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Table 2: Fruit weight of three tomato varieties as affected by staking and spacing

Treatment	Average Fruit weight (g)	Marketable fruit weight (t/ha)	Unmarketable fruit weight (t/ha)	Fruit yield (t/ha)
Variety				
UC82B	42.34	3.25	1.98	5.23
Tropimech	45.22	3.93	1.32	5.26
Ibadan local	48.75	5.71	2.41	8.12
LSD	3.34	0.84	0.61	1.16
Staking				
Staked	48.60	4.86	2.07	6.60
Unstaked	42.30	3.74	1.73	5.81
LSD	2.73	0.70	0.50	0.95
Spacing				
60 cm x 30 cm	43.55	5.13	2.52	7.70
60 cm x 45 cm	43.74	3.72	1.50	5.21
60 cm x 60 cm	49.00	4.04	1.70	5.73
LSD	3.34	0.84	0.61	1.16
F Sig. ($P \leq 0.05$)				
Variety (V)	ns	**	**	**
Staking (St)	**	**	ns	Ns
Spacing (Sp)	**	**	**	**
V × St	ns	ns	ns	Ns
V × Sp	**	ns	ns	Ns
St × Sp	**	ns	ns	Ns
V × St × Sp	**	ns	ns	*

*, ** indicate significance effect of the treatment at 5% and 1% probability level.
ns mean not significant
V means variety, St means Staking while Sp means Spacing

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Insecticidal Efficacy of Some Plant Aqueous Extracts Mixtures against Post Flowering Insect Pest of Cowpea

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Abstract
Field experiment was conducted to evaluate the efficacy of single and mixtures of Petivera alliaceae, Datura stramonium and Luffa cylindrica aqueous extracts against post flowering insect pest of cowpea. The study consists of application of seven treatments laid out in complete randomised block design and replicated three times. Data on insect population were taken prior to the commencement of treatment application, 3 and 7 days after spraying, number of damaged pods, undamaged pods, total number of harvested pods and seed weight. Results obtained shows that L. cylindrical plant extract sole application and its mixtures significantly reduced insect population, numbers of pods damaged and improve cowpea yield compared to single application of P. alliacea and D. stramonium extracts. Application of P. alliacea + L. cylindrical and L. cylindrica + D. stramonium aqueous extracts mixture by resource poor farmers is hereby advocated as potential alternative to synthetic insecticides.
Keyword: *Datura stramonium, insect population, Luffa cylindrical, Petivera alliaceae, pods damaged*

INTRODUCTION

Cowpea (*Vigna unguiculata* L.) Walp) Fabaceae is an important food grain legumes consumed to meet the daily dietary protein requirement by teeming human population in many parts of Nigeria. Despite cowpea nutritional qualities, its production and consumption is still limited owing to complex of insect pest infestation. The annual yield loss due to the insect pests has been estimated at about 30 per cent and complete crop failure may occur especially in situation where control measures are not applied. However, cowpea yield in Nigeria can be improved and raised to tenfold, when insects are controlled with insecticides (Booker, 1965). The major insect pests complex known to attack cowpea at pre-flowering, flowering and post flowering consist of *Seriesthrips occipitalis, Clavigralla tomentosicollis, Taeniothrips sjostedti, Maruca testulalis, Acythomyia horida, Riptortus dentipes* and *Anoplocnemis curoipes* (Singh et al 1997) causing damage from 50% (Raheja, 1976).

The use of synthetic insecticides has been the most widely use control measure and its uses has led to numerous problems unforeseen at the time of their introduction and this has necessitated the search for alternative control measures that are eco-friendly and pose no health and environmental threat such as botanicals. The use of plants in insect pest management is not only useful for suppression of pest population but also helps to maintain the sound ecological balance. Therefore, the purpose of this study is to evaluate the efficacy of aqueous extracts of *Petivera alliaceae*, *Datura stramonium* and *Luffa cylindrica* and their mixtures for the control of post flowering insect pests of cowpea.

MATERIALS AND METHODS

The experiment was laid out in a Randomized Complete Block Design (RCBD) with seven (7) treatments and replicated thrice (3 times) on a total land area of 135m^2 well prepared at the Teaching, Research and Commercial Farms of Rufus Giwa Polytechnic, Owo, Ondo State. Each plot measured

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2.5m×1.5m ($3.75m^2$) with 0.5m alley between plots. Two seeds of 'Oloyin cultivar was planted per hole at spacing of 75cm along the rows and 25cm within the rows and later thinned to one stand per hole two weeks after planting.

One hundred (100) grams each of *P. alliaceae*, *D. stramonium* and *L. cylindrica* plants collected from different locations in Owo metropolis were washed to remove dirt, thereafter homogenized with mortar and pestle. The homogenized materials were soaked for 24 hours in 5 litres of water. The crude aqueous extracts were then filtered through a muslin cloth to obtain aqueous extract which was stored till use. The leaf extracts were applied thoroughly on the cowpea plant when it attained 50% flowering at the rate of 50% w/v, while the synthetic insecticide (use as check) was applied at a concentration of 50ml to 15 litres of water. The spraying was maintained till harvesting of the matured pods.

To determine the effect of aqueous plant extracts in suppressing insect infestation and damaged to cowpea, insect pests were visually counted during the early hour of 6a.m - 7a.m when most of the insect are inactive from the middle row of each plots. Insect count was also carried out at 3 and 7 days after each spray (DAS). Harvesting was done at 5 days interval when the pods show indices for maturity and the following data were collected: number of infested (damaged) pods, number of undamaged pods, number of harvested pods and grains weight. Data collected were subjected to Analysis of Variance (ANOVA) and significant treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5% probability level.

RESULTS

The generality of insect population before spraying was not significantly different from each other in all treatment assessed (Table 1). However, plots assigned to be treated with *L. cylindrica* and Lambda-cyhatholin had the highest number of pest population (5.67) and (5.00) respectively while *D. stramonium* assigned plots had the least population of pest (3.00).

Results for the insect population after the fourth spraying with the sole aqueous plant extracts and their mixture were shown in Table 2. Data obtained shows that the treatments exhibited varying level of insect infestation suppression. Cowpea sprayed with synthetic insecticide recorded the lowest insect population. Among the sole aqueous plant extracts, *D. stramonium* recorded the lowest population of *O. mutabilis* (0.33), *L. cylindrical* (0.67) *A. acutums* and *O. mutabilis* respectively. Similar trend was observed for the mixture of *P. alliacea* + *L. cylindrical* and *L. cylindrica* + *D. stramonium.* Result presented in Table 2 clearly indicated that the insect population were put under check 3 DAS for all the treatments.

The result in Table 3 shows that yield obtained from plots treated with synthetic insecticide was significantly different from those treated with aqueous plant extracts in terms of seed weight, damaged pods, undamaged pods and total number of pods produced. The result also showed that cowpea plants treated with single aqueous plant extracts were not significantly different from each other but were significantly different from cowpea treated with mixture of the aqueous plant extracts.

DISCUSSION

The result presented in the study demonstrated the potential of aqueous plant extracts in reducing infestation and damage caused by pod sucking bugs (PSBs) and pod borers. Pesticides both synthetic and botanical no doubt markedly reduce pest infestations and increase seed yield of crops. The result shows that the application of extracts (*P. alliacea, L. cylindrica, D. stramonium*) on cowpea plant had a positive effect in the control of post flowering pest of cowpea as it visibly reduces insect pest of cowpea. The population suppression ability of the plant extracts suggested that the plant materials possess insecticidal properties and is in conformity with the works of Owolade et al. (2004) and Stoll (2001) who reported that there are many botanical extracts of crop that are known to be effective in controlling various insect of crops.

In this study spraying with synthetic pesticide controlled the insect pest and increased cowpea yield tremendously as compared to spraying with botanical insecticides. This result is in line with earlier works by Agona et al (2001, 2002) and Opolot et al. (2006) where synthetic pesticides were adjudged to be more effective than the botanical pesticides. (Adebayo and Olaifa, 2004). The instance where there are surge in the insect population, indicates that the extract slow acting mortality agent and easily degraded. Above all, the efficacy observed from the study supported Dzemo et al, (2010) who reported that aqueous plant extract significantly reduces the infestation of pod borers and pod sucking bugs (PSBs) on cowpea, thereby reducing pod and seed damage and increasing grain yield.

CONCLUSION

The study showed that mixture of tested plant extracts exhibited potent insecticidal activity in suppressing cowpea post flowering insect pests due to the synergetic influence of the phytochemicals present in the mixed extracts. Therefore, adoption mixture of *P. alliacea* + *L. cylindrical* and *L. cylindrica* + *D. stramonium* aqueous extracts by resource poor farmers is hereby advocated as potential alternative to synthetic insecticides.

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Table1: Insect population before spraying with botanical insecticides

Treatments	Insect population
Lambda-cyhatholin	5.00±2.64
P. alliaceae	3.33±0.88
L. cylindrica	5.67±1.76
D. stramonium	3.00±1.20
P. alliaceae + L. cylindrica	3.33±0.88
P. alliaceae + D. stramonium	3.67±1.33
L. cylindrica + D. stramonium	3.67±1.33

Table 2. Post flowering insect population of cowpea after fourth spraying with plant aqueous mixture

Treatments	*Nezera viridula*		*Acrostenum acutums*		*Cerotoma trifurcate*		*Oetheca mutabilis*	
	3 DAS	7DAS	3 DAS	7DAS	3 DAS	7DAS	3 DAS	7DAS
Control	0.33±0.33^{a}	1.00±0.58^{a}	0.0	1.33±0.67^{ab}	0.0	0.67±0.33^{a}	0.0	0.0
P. alliacea	2.67±0.67^{b}	3.67±0.88^{c}	1.33±0.67^{b}	2.67±1.67^{bc}	0.0	1.33±0.33^{b}	1.33±0.33^{b}	. 0±0.58^{b}
L. cylindrical	1.67±0.67^{ab}	2.0±0.58^{ab}	0.67±0.67^{a}	2.33±0.88^{b}	1.0±0.58^{ab}	2.67±1.45^{b}	0.76±0.33^{a}	1.33±0.33^{b}
D. stramonium	2.33±1.45^{b}	3.33±1.45^{c}	1.0±0.58^{ab}	3.00±1.00^{c}	0.0	1.33±0.33^{ab}	0.33±0.33^{a}	0.33±0.33^{a}
P. A. + L. C.	1.67±0.88^{ab}	2.67±0.67^{b}	0.0	0.33±0.33^{a}	0.67±0.67^{a}	2.33±0.88^{b}	0.33±0.33^{a}	1.67±0.67^{b}
P.A + D. S	2.0±0.58^{b}	3.0±0.58^{bc}	0.0	0.67±0.33^{a}	1.67±0.88^{b}	2.67±0.33^{b}	0.33±0.33^{a}	0.67±0.67^{a}
LC +DS	2.33±1.33^{b}	3.67±1.20^{c}	0.67±0.67^{a}	1.33±0.58^{ab}	0.0	1.33±0.33^{ab}	0.67±0.33^{a}	1.33±0.88^{ab}

Treatments with different alphabet in same column are significantly different using DMRT at 5% probability

P. A. = *Petivera alliaceae,* L. C. = *Luffa cylindrical,* D. S. = *Datura stramonium*

Table 3. Effects of aqueous plant extracts mixture on cowpea yield, pod damage and seed weight

Treatments	no of undamaged pods	no of damaged pods	total no of harvested pods	seed weight (kg)
Control	125.67±10.48^{a}	1.87±0.58^{a}	312.67±17.49^{a}	0.30±0.03^{a}
P. alliacea	42.33±18.10^{b}	38.67±17.75^{c}	81.00±17.93^{c}	0.07±0.03^{b}
L. cylindrical	57.67±29.41^{b}	50.00±19.86^{b}	107.67±24.64^{b}	0.09±0.04^{b}
D. stramonium	48.67±24.37^{b}	53.67±34.29^{b}	102.34±29.32^{b}	0.10±0.07^{b}
P. A. + L. C.	39.00±8.02^{b}	30.00±3.50^{c}	69.00±9.77^{c}	0.04±0.01^{c}
P.A + D. S	14.67±2.33^{c}	17.67±8.09^{d}	32.34±6.38^{c}	0.03±0.01^{c}
LC +DS	28.00±7.57^{d}	30.00±7.51^{c}	58.00±7.54^{c}	0.05±0.01^{c}

Treatments with different alphabet in same column are significantly different using DMRT at 5% probability

P. A. = *Petivera alliaceae,* L. C. = *Luffa cylindrical,* D. S. = *Datura stramonium*

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The Effect of Colchicine on Growth of *Begonia semperflorens*.

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Abstract
Chemical mutagen can induce mutation in ornamental crops. Begonias are plants with bright showy leaves flowering all year round. They are used in window boxes, patio plant or as bedding plants. This experiment was conducted at the screen house, Floriculture Programme, of National Horticultural Research Institute ($7^0$25"N and $3^0$52"E), Ibadan, Oyo State, Nigeria, to evaluate the growth and response of begonia to different concentrations and time of soaking in colchicine. Cuttings of Begonia (Begonia semperflorens) were planted in black polythene nursery bags of 5cm by 6cm filled with topsoil. The treatments include: (0, 300, 500 and 800) mgL^{-1} colchicine; and four soaking time of (0, 1, 2 and 3) hr. The experiment was arranged in a Completely Randomized Design (CRD) with five replications. There were dose related effects of the mutagenic treatment on the quantitative traits. Significant difference at ($P<0.05$) were observed on the growth of Begonia semperflorens. 300mgL^1 dose for the varying soaking time produced higher plant height and stem diameter while 500mgL^1 dose produced small leaves with decreased leaf area. Begonia semperflorens with improved quality were produced.
Keywords: *Begonia, Colchicine, mutagenesis, growth and development.*

INTRODUCTION

Begonia is a genus of perennial flowering plants in the family Begoniaceae. The genus contains about 1,400 different plant species. Begonia is found in moist subtropical and tropical climates. Some species are commonly grown indoors as ornamental houseplants in cooler climates. In cooler climates some species are cultivated outside in summertime for their bright colourful flowers, which have sepals but no petals. Begonias are used as ornamental plants in window boxes, patio plant or as bedding plants. They have bright showy leaves and flowers all year round. Colchicine is a polyploidising and mutagenic agent (Ramesh *et al*., 2011). New plant varieties can be developed from seeds or vegetative cuttings through induced mutation by the use of mutagens (Ahloowalia and Maluszynski, 2001; Arulbalachandran *et al.,* 2009), The objective of this study was to determine the growth response of *Begonia semperflorens* to different concentrations and time of soaking in colchicine, a mutagenic agent, in Ibadan, Nigeria.

MATERIALS AND METHODS

The experimental site was the screen house of the Floriculture Improvement

Programme, National Horticultural Research Institute (NIHORT), Ibadan, Oyo State, Nigeria (3^0 52'E and 7^0 25'N). Cuttings of Begonia (*Begonia semperflorens*) with eight (8) nodes were planted in medium sized (5cm by 6cm) black polythene nursery bags filled with topsoil. A cutting was planted per nursery bag. The experiment was 4 x 4 factorial trial with five replications. The treatments were: four concentrations of colchicine (0, 300, 500 and 800mgL^{-1}) and four soaking time where cuttings were soaked in different concentrations of colchicine (0, 1, 2 and 3 hours) before planting. The experimental design was a Completely Randomized Design (CRD) with five replications. Data were collected on plant height; stem girth, number of leaves and leaf area from three weeks after planting. An equal amount of water was applied to each plant throughout the course of the experiment. Nursery and other cultural practices were carried out. Data collected were analyzed by SAS 2000 and means were separated by least significant difference (LSD) at ($P < 0.05$).

RESULTS AND DISCUSSION:

Effects of concentration and soaking time of colchicine on the plant height and number of leaves of *Begonia semperflorens*

Significant responses were observed in the height of begonia with different concentrations of colchicine and varying soaking time. Highest plant height was observed at 300mgL^{-1} and 1 hour of soaking in colchicine from 3, 4, 5 and 6 weeks after planting (WAP). Highest height (10.2cm) while the non-soaked 500 mgL^{-1} concentration of colchicine produced a significantly (P=0.05) lower plant height of begonia (Table 1). Highest number of leaves was observed at 800mgL^{-1} for 3 hours of soaking in colchicine from 3, 4, 5 and 6 weeks after planting (WAP). The highest number of leaves was 5.6 at 6 WAP (Table 2).

Effects of concentration and soaking time of colchicine on the stem diameter and leaf area of *Begonia semperflorens*

Significant responses were observed in the stem diameter of begonia with different concentrations of colchicine and varying soaking time. The least stem diameter was observed at 500mg L^{1} for 3 hours of soaking in colchicine. For 3, 4, 5 and 6 WAP, begonia cuttings treated with colchicine at 300 mgL^{1} for 3 hours showed no increase in stem diameter. However, the highest stem diameter was observed with control treatment (0 mgL^{1}, 0 hr.) for 4, 5 and 6 WAP (Table 3). Significant responses were observed in the leaf area, 500mg L^{1} for 2 hours of soaking in co lchicine had the highest leaf area (35.40cm^{2} and 43.20cm^{2}) for 5 and 6 WAP. The least leaf area observed at 300mg L^{1} for 3 hours at 6 WAP was 5.20m^{2} (Table 4).

The effect of concentration and soaking time of colchicine on growth of Begonia semperflorens showed significant response. Colchicine at lower concentration increased the plant height and number of leaves while at higher concentration, the plants had shorter stem diameter and leaf area which agreed with the finding of (Ahloowalia and Maluszynski, 2001; El-Nashar and Asrar, 2016). Colchicine has been used to induce mutation in several plants. The stunted growth at higher concentration is due to reduced rate of cell division (Ramesh *et al.*, 2011). The heterozygous nature of ornamental plants allows for detection, selection and conservation of mutants at different generations (Adelanwa, 2011; Mba, 2013). Mutation induction is applied with the objective of changing growth habit, vegetative and reproductive morphology (Annegret, 2003).

CONCLUSION

Induced mutation is a remarkable method for creating genetic variability in ornamentals when desirable characters are expected. The frequency and type of mutation are dependent on the concentration and duration of soaking in different mutagens.

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Table 1: Effect of concentration and time of soaking on Plant height (cm) of Begonia

Concentration (mgL^{-1})	Time (hours)	Weeks after planting			
		3	4	5	6
0	0	1.8	1.8	2.6	2.8
	1	3.0	3.5	3.8	3.8
	2	6.2	6.2	7.4	7.4
	3	4.1	4.3	4.3	4.8
300	0	5.0	5.0	5.0	6.6
	1	8.4	8.6	8.8	10.2
	2	1.2	1.4	5.6	6.0
	3	4.8	5.8	5.8	7.4
500	0	0.4	0.6	2.1	2.2
	1	3.0	3.5	3.6	3.8
	2	1.6	2.0	5.0	5.0
	3	0.9	2.7	2.8	3.4
800	0	4.5	4.8	5.3	5.6
	1	2.3	2.6	2.6	3.0
	2	4.6	5.0	5.0	5.9
	3	6.1	6.1	6.1	8.0
LSD		3.994	4.381	3.774	4.390

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Table 2: Effect of concentration and time of soaking on the number of leaves of Begonia

Concentration (mgL^{-1})	Time (hours)	Weeks after planting			
		3	4	5	6
0	0	1.8	2.2	2.6	2.6
	1	2.0	2.2	2.2	2.4
	2	3.0	3.0	3.4	3.4
	3	3.0	3.2	3.4	4.0
300	0	3.6	4.6	4.6	4.8
	1	2.8	3.0	3.6	3.6
	2	0.6	1.0	2.4	2.6
	3	3.6	3.6	3.8	4.2
500	0	0.6	0.6	0.8	1.0
	1	0.8	0.8	0.8	0.8
	2	0.4	0.6	1.6	1.8
	3	0.2	1.4	1.6	1.8
800	0	2.8	3.8	3.8	4.4
	1	1.2	1.2	1.4	1.6
	2	2.0	2.0	2.0	2.8
	3	4.8	5.2	5.2	5.6
LSD		2.451	2.658	2.467	2.712

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Table 3: Effect of concentration and time of soaking on the stem diameter (cm) of Begonia

Concentration (mgL^{-1})	Time (hours)	Weeks after planting			
		3	4	5	6
0	0	0.16	0.76	0.76	0.76
	1	0.14	0.14	0.16	0.16
	2	0.08	0.08	0.08	0.10
	3	0.20	0.24	0.26	0.30
300	0	0.20	0.20	0.20	0.20
	1	0.20	0.20	0.20	0.20
	2	0.08	0.08	0.20	0.22
	3	0.10	0.10	0.10	0.10
500	0	0.04	0.04	0.22	0.24
	1	0.12	0.12	0.12	0.12
	2	0.06	0.06	0.16	0.16
	3	0.02	0.08	0.10	0.10
800	0	0.22	0.22	0.22	0.22
	1	0.06	0.08	0.10	0.10
	2	0.18	0.20	0.20	0.20
	3	0.16	0.16	0.20	0.24
LSD		0.164	0.271	0.257	0.262

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Table 4: Effect of concentration and time of soaking on the leaf area (cm^2) of Begonia

Concentration (mgL^{-1})	Time (hours)	Weeks after planting			
		3	4	5	6
0	0	4.04	6.60	7.80	10.60
	1	11.40	14.20	16.40	18.20
	2	6.80	6.80	7.20	9.00
	3	4.10	4.90	7.40	8.10
300	0	10.40	12.00	13.20	14.60
	1	16.80	21.40	24.00	29.80
	2	6.00	9.80	21.10	27.40
	3	2.32	2.60	2.60	5.20
500	0	3.00	4.80	6.00	18.60
	1	9.40	11.00	13.00	14.60
	2	12.60	14.40	35.40	43.20
	3	1.20	5.20	6.80	13.20
800	0	20.80	21.20	21.40	21.60
	1	3.36	5.80	5.80	6.80
	2	8.40	11.00	11.00	15.60
	3	22.40	22.80	23.60	25.20
LSD		17.682	23.466	17.651	21.601

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Potential of Sweet Orange (*Citrus sinensis* L. Osbeck) Peel Extract as Insecticidal Agent against Cowpea Bruchid, *Callosobruchus maculatus* (F.) (Coleoptera: Chrysomelidae: Bruchinae)

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Abstract
Laboratory experiments were conducted to examine the insecticidal potentialof C. sinensis peel extract against cowpea bruchid,Callosobruchusmaculatus(F.) (Coleoptera: Chrysomelidae). The effectiveness of C. sinensispeel extract was determined as seed protectant against damage by adult cowpea beetle, C. maculatus at 0, 5, 10 and 15 µl administered on Whatman No. 1 filter paper in 100 µl methanol using micropipette and placed in a 9 cm Petri dish with a cover. Citrus peel oil was extracted using the Soxhlet extraction technique and the oil was concentrated in steam water bath at 40^{0}C. The experiment was arranged in a completely randomized design (CRD) replicated four times. Ten unsexed 1–2 day old adult C. maculatus were introduced on 20 g cowpea seed placed in the Petri dish containing different rates of extracts. Methanol extract of Citrus peel at the highest concentration gave complete mortality 2 days after treatment (DAT). The results also showed that cowpea seeds loss in all the peel extract-treated seeds was significantly (p<0.05) lower (1.17-3.40%) than in the control (3.30-6.33%). The higher concentrations of peel extract caused significant reduction in progeny emergence of the insect. The present study shows that the sweet orange extract has potential to cause mortality of C. maculatus and so can be used against the pest under small scale storage.

Key words: *Bruchid,Callosobruchusmaculatus***,** *plant extracts, sweetorange***.**

INTRODUCTION

In Nigeria, the most important pest of stored legume seeds is cowpea bruchid, *Callosobruchusmaculatus*(Coleoptera: Chrysomelidae: Bruchinae). It affects mature cowpea seeds in the field from where it is carried to the store where greater damage is often caused by the beetle. It is therefore regarded as a field-to-store pest. Ofuya*et al*. (2007) reported that damaged cowpea seeds are defaced with egg chorions and riddled with adult exit holes and subsequently have reduced weight, poor marketability and low viability.

Conventionally, farmers control stored product insect pests by means of synthetic insecticides such as pyrethroids, organophosphates and fumigants. In view of the environmental and ecological concerns, human health hazards, and increasing insect resistance, many insecticides have been banned or replaced by newer chemicals (Pimentel *et al*., 2010; El-Bakry *et al*., 2016; Rajashekar *et al*. 2016). The current trend includes the continued search for sound and sustainable pest management approaches that are locally available, farmer friendly, affordable and biodegradable.

El-Wakeil (2013) reported that botanical pesticides have long been touted as attractive alternatives to synthetic chemical pesticides for pest management because botanicals reportedly pose little threat to the environment or human health. Several studies revealed that the essential oils of *Citrus* spp. have potential to act as repellents, fumigants, ovicides, larvicides, insecticides and insect growth regulators against various insect species (Mondal and Khalequzzaman, 2009; Nenaah, 2014). Reports also showed that essential oil derived from orange peels is known to have insecticidal activity against beetles, notable among them are lesser grain borer, *Rhyzopertha dominica* (F.), rice weevils, *Sitophilus oryzae* (L.) and red flour flour beetle, *Tribolium castaneum* (Herbst) (Tripathi *et al*., 2003). Moravvej and Abbar (2008) reported that volatile components of *Citrus paradise* Macf., *C. aurantium* Risso, *C. limonium* Risso and *C. sinensis* peel essential oils had high fumigant activity against cowpea adult bruchid, *Callosobruchus maculatus* (F.). Having considered the availability of sweet orange peels as wastes in the country, methanol extract of the plant part was tested against bean beetle, *C. maculatus*in stored cowpea seeds.

MATERIALS AND METHODS

Study site

The experiment was carried out under laboratory conditions of the Department of Crop Protection, University of Ilorin, Ilorin, Nigeria at ambient temperature of 28±3^{0}C, relative humidity of 68±3% and photoperiod 12:12 (L:D).

Test insect

Fifty unsexed adults of cowpea bruchids collected from a local market were raised on 200 g susceptible cowpea seeds in a 250 ml Kilner jar. The jar was covered with a mesh lid to permit aeration and prevent insect escape. The parent adults were sieved out after being allowed to lay eggs for 3 days. Parent adults were removed to avoid overlap with the freshly emerged adults (1-2 day old) used for the study.

Seed disinfestation

A bag of cowpea seeds already disinfested for 72 h with 2 tablets of Phostoxin® was sorted while 5 kg seeds used for the experiment was thereafter spread on the laboratory desk to allow the gas to dissipate.

Preparation of *C. sinensis* peel extract

Fresh peels of *C. sinensis* fruits were collected from a grocer in a local market in Ilorin. The peels were chopped into pieces using sterilized scalpel and ground using electric blender (Kenwood BL335,12B07). The powder was sieved to obtain uniform particles that passed through 40 mesh sieve. The *C. sinensis* peel powder (20 g) was properly wrapped in tissue paper and placed in the thimble of Soxhlet extractor while 200 ml methanol (solvent) was introduced for extraction continuously for 6 h. The peel oil extracted was concentrated on a steam bath set at 40^{0}C. The extractant was stored at 4^{0}C in a vial for 24 h prior to use.

Experimental procedure

Mortality activity of *C. sinensis* peel extract was tested against adults of *C. maculatus* by contact action. The different concentrationsof 5, 10 and 15 µl extract were applied separately on Whatman No. 1 filter paper in 100 µl methanol using micropipette. The filter paper was dried to dissipate the methanol for 10 min. before transferring into Petri dish (9 cm diameter). Ten adults of *C. maculatus*(mixed sexes of 1-2 days old) were placed with 20 g cowpea seeds in the container (7.4 cm in diameter).Three replications were set for each concentrationincluding the control (seeds treated with methanol alone) using micro-pipettein a completely randomized design. Data for adult mortality was recorded 24 and 48 days after treatment (DAT).

The experimental arrangement was kept for progeny assessment. The treated and untreated seeds were thereafter examined daily for emergence of progeny. Count of emerged adults commenced 28 days after infestation and a daily count was made for 5 consecutive days according to the method adopted by Emeasor*et al*. (2007).

Damage assessment was carried out on treated and untreated seeds. The extent of bruchid damage to seeds was evaluated by

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counting the exit holes. Damage by the beetle to the seeds was assessed 90 DAT using the number of perforated seeds as the index. Samples of 100 seeds were taken from treated and untreated seeds and the number of damaged (seeds with characteristic holes) and undamaged seeds were counted and weighed. Percentage weight loss was calculated by count and weight method as described in FAO (1985) as follows:

$$\% \text{ weight loss} = \frac{UaN-(U+D) \times 100}{UaN}$$

Where:
U= wt of undamaged fraction in the sample, N
N=total number of seeds I sample
Ua=average weight of one undamaged seeds
D=weight of damaged fraction in the sample

Data analysis

Data were subjected to one-way analysis of variance and significant differences between means were determined using the Least Significant Difference at p=0.05.

RESULTS AND DISCUSSION

The *C. sinensis* peel oil extracted with methanol caused mortality of test insect at all concentrations that were significantly ($P \leq 0.05$) higher than mortality in control at 1 and 2 DAT (Table 1). Results of this study showed that *C. sinensis* methanol extract caused high mortality of *C. maculatus*and is effective as contact botanical against *C. maculatus*. Peel extract of *C. sinensis* applied at all concentrations showed significant effect. At the highest concentration of 15 µl, total mortality (100%) of *C. maculatus* was recorded 2 DAT. No dead beetles were observed in the control. All concentrations showed significantly higher mortality than the control. It was found that the effectiveness of the plant extract was dependent on both concentration and exposure period. In all the concentrations tested, seed protected with the highest concentration (15 µl) of plant extract gave better protection against the test insect than lower concentration. In this study the insecticidal activity of the extract might be dependent on the ability of the oil to dissolve the lyphophytic fatty tissues of the exoskeleton. The insecticidal activity of *C. sinensis* methanol extract to the test insect may be ascribed to solubility of the active ingredients in the extract. The essential oil of *C. sinensis* showed contact toxicity against *Zabrotessubfasciatus* L. (Zewde*et al.*, 2010). The *C. sinensis*extract applied at various concentrations indicated varying contact action to adults of *C. maculatus*. There was no mortality in the control within 2 days of treatment when adult mortality was achieved in all concentrations. Moravvej and Abbar (2008) had earlier reported that at 12 h exposure, the minimum rates of mortality of 5% in adults were attained by the presence of 148 µl L^{-1} of *C. sinensis*peel oil. In this study, the *C. sinensis*extract recorded 100% mortality against the test insect at 15 µl within 2 days of treatment. The study shows that mortality of the insect increased with exposure time. The emerged *C. maculatus*adults in the *C. sinensis*peel extract concentrations were significantly ($p<0.05$) lower than in the control except for 5 µl at 29, 30 and 31 DAT (Table 1). Conversely, significantly higher mean number of *C. maculatus*adults emerged in the control treatment than in seeds protected with highest concentration of the extract except at 28 DAT. All concentrations of the peel extract caused significant reduction in adult emergence of *C. maculatus* when compared to the control at 32 DAT, but there was no significant ($p>0.05$) difference among the various concentrations of the extract and the control at 28 DAT. *Citrus sinensis* extract at the highest concentration of 15 µl completely suppressed *C. maculatus* emergence at 28 DAT. Although, adult emergence was higher in seeds treated with 5 µl, differences in emergence were not significant compared with control at 30 and 31 DAT.

Weight loss assessments of the treated and untreated seeds are shown in Table 2. All the treatments significantly ($p<0.05$) reduced weight loss compared to the untreated control at 1, 2 and 3 months after treatment. However noticeable feeding damage was observed on all treated and untreated seeds. Dawit and Bekelle (2010) reported that essential oil of orange peels effectively reduced the grain damage weight loss.

The *C. sinensis* methanol extract caused reduction in the number of seeds damaged by *C. maculatus*. The number of damaged seeds was significantly ($p<0.05$) lower at the various concentrations and the control except for 5 µl at 1 month after treatment (MAT). However, no significant differences were recorded in the number of damaged seeds in the concentrations of 10 and 15 µl at 2 and 3 MAT (Table 2) suggesting that any of the concentrations could be used to tackle the menace of the insect pest. The study revealed that adopting adult control through the peel extract would reduce damage caused by the insect, thus avoiding insect population build up on the stored seeds. The reduction in rate of adult emergence may have been caused by inhibition of egg laying or hatching by the plant extract. The short comings include the need to collect large quantities of the peels for extraction purposes. Tripathy*et al*. (2003) reported the contact toxicity of d-limonene present in *Citrus* spp. against stored-product insects. In another investigation, Oboh*et al*. (2017) reported that percentage mortality of insects increased with increase in concentration of the essential oil and exposure time. They associated the effectiveness of the essential oil to its inhibitory effects on acetylcholinesterase and Na+/K+=ATPase activity. Although, insecticidal components of *C. sinensis* extract were not examined in this study, insecticidal activity may probably be due to the presence of limonene, myrcene, α-pinene, linalool, octanal and decanal (Njoroge*et al.* 2009).

CONCLUSION AND RECOMMENDATION

The study has shown that *C. sinensis* peel extracted with methanol can be exploited for use as seed protectant. The results of this study have the potential to increase the utilization of *C. sinensis* methanol extract for post-harvest protection of cowpea seeds under small scale storage. Adoption of this botanical control is recommended to reduce environmental pollution attributed to citrus peel wastes. Since the peels are not known to be toxic to human health, they could be added directly to seeds meant to be stored for future use.

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Table 1. Contact action of *C. sinensis*peel extract against*C. maculatus* and its progeny emergence

Concentration (µl) of *C. sinensis* peel extract	Mean mortality of *C. maculatus*adults (DAT)		Mean adult emergence of *C. maculatus*(DAT)				
	1	**2**	**28**	**29**	**30**	**31**	**32**
0	0.00	0.00	1.0	1.62	2.14	2.87	2.87
5	5.67	9.67	0.67	1.38	1.90	2.37	2.37
10	6.33	9.67	0.33	1.00	1.62	1.80	1.80
15	7.33	10.00	0.0	0.33	1.14	0.41	1.38
LSD$_{(0.05)}$	**3.02**	**0.58**	**NS**	**0.53**	**0.41**	**0.55**	**0.16**

Values are means of three replicates. DAT=Days after treatment NS= Not significant

Table 2. Contact effect of *C. sinensis*peel extract on number of cowpea seeds damaged and percentage seed weight loss by *Callosobruchus maculatus*

Concentration (µl) of *C. sinensis*	Mean No. of damaged seeds (MAT)			% Seed weight loss (MAT)		
	1	**2**	**3**	**1**	**2**	**3**
0	4.58	21.00	28.00	3.30	5.71	6.33
5	3.40	11.67	17.33	1.70	2.43	3.40
10	2.30	5.67	7.33	1.67	2.84	2.87
15	1.71	3.00	5.67	1.17	1.75	2.00
LSD$_{(0.05)}$	**0.70**	**4.06**	**3.02**	**2.19**	**1.13**	**1.57**

Values are means of three replicates.MAT=Month(s) after treatment

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Preliminary Study of Effect of Herbicide Rotation on Growth and Yield of Roselle (*Hibiscus sabdariffa* L.) in the Alley of Citrus Trees

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Abstract
A field trial was conducted at National Horticultural Research Institute, Ibadan, to conduct a preliminaryinvestigation of theeffect of herbicide rotation on growth and yield of roselle in the alley of citrus trees in the orchard. Treatments included paraquat, glyphosate, metolachlor + hoeing, metolachlor + glyphosate and no weeding ascontrol.The spacing for roselle was 60cmx 30cm,the spacing for citrus was 5mx5m, while the plot size was 6m x 3m. Data collected includes growth attribute of citrus, roselle growth and yield at 1m,2m and 3m away from citrus tree and weed biomass. The experimental design was Randomized Complete Block Design (RCBD) in 4 replications. The data collected were subjected to analysis of variance (ANOVA) using SAS analysis and means were separated using Duncan Multiple Range Test (DMRT) at $p \leq 0.05$. Results revealed that significantly higher fruit yield (17.7) and calyx dry weight (19.8g) was recorded from glyphosate treated plots at 1m away from the citrus tree. No significant difference was observed on number of fruit and calyx dry weight at 3m away from the citrus tree. Tallest citrus tree (260.7 cm) was recorded from plots treated with metolachlor+glyphosate. The check(No weeding plots) recorded significantly wider collar diameter (9.8 cm) and scion diameter (7.6 cm). Significantly least weed biomass of 15.0 g/m^{2}was recorded from paraquat treated plots.

***Keywords**: - Weed biomass, Herbicide, Calyx, Weed interference, Roselle yield.*

INTRODUCTION

Citrus (*Citrus spp*) is one of the most important fruit trees grown for fresh consumption and as raw materials for marmalade and juice production in the tropics and sub tropics (Adewale *et al*., 1996; Olaniyan *et al*., 2001; Alamu *et al*., 2011). Sweet orange (*Citrus sinensis* Osbeck Cv Agege 1) is the most widely grown type of citrus fruit, by far, it account for around 55% of the citrus area and over 60% of production. Its importance is due to the high vitamin C content in the fruit, high industrial potential for manufacturing concentrates, fruit juice, squash marmalades, essential oils and flavouring purposes (Davies and Albrigo, 1994; Futch and Singh 1998; FAO 2008).

Intercropping tree crops with staple food crops before canopy closure is a common practice by farmers (Andor and Ofosu-Budu, 2012). The cropping system of citrus vary with the agro-ecology, in the southwestern zone of Nigeria, citrus is grown as a home compound crop with other crops, it serves for home consumption and in year of heavy bearing, surplus fruit are sold for cash (Olaniyan 2001). In the southwestern zone, citrus is interplanted with *Theobroma cacao* (Cocoa), *Cola spp*. (Kola) and *Musa paradisiaca* (Plantain) to generate extra income (Amih, 1985; Aiyelaagbe *et al.,* 2001). In the middle belt, identified to be the largest citrus producing area in Nigeria, the farmers intercrop the alley of citrus orchard with *Vigna unguiculata* (Cowpea), *Glycine max* (Soybean) and sometime *Manihot esculenta* (Cassava).(Aiyelaagbe,2001)

Citrus is grown at a recommended spacing of 7m x 7m and this makes it possible and convenient to utilize the alleys for growing other crops especially at the juvenile stage. The attendant cultural operation in maintaining sole citrus are usually capital intensive during the early stages, due to the wide spacing with no monetary returns in the first five years of orchard establishment

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(Olaniyan 2001).In southern part of Nigeria, a number of crops have been found to be compatible with citrus such as cowpea, okra, watermelon, amaranths and maize (NIHORT, 2000).

The intercropping systems being practiced for citrus presently puts citrus as the minor crop in the system, the compatibility of the companion crop with citrus is therefore not of much concern. The compatibility of the different intercrop needs to be carefully studied to justify their inclusion in citrus orchard alleys. Inclusion of the intercrops (fruit vegetables and spice crops) will encourage farmers to maintain the young citrus plants, serve as a source of income to the farmers.

Weeds have been reported to significantly contribute to direct yield losses of crops by competing for water, nutrients, light, space and/or carbondioxide. Akobundu (1987) reported that 50 to 80 % crop yield loss is caused by weeds, probably due mainly to delay in weeding. In addition to competition for limited growth resources, it has also been generally observed that weeds also act as reservoirs or alternate hosts for insects, diseases and nematodes (Singh and Sharma, 2010). The main problems limiting production and expansion of roselle pointed out by El-Awad, (2001) are, scarcityand reliability of rainfall, limited research and agricultural extension services, poor cultural practices,inadequate weed control and harvest problems. Hoe weeding is still by far the most widely practiced culturalweed control technique in field crop production throughout the tropics because of the prohibitive costs ofherbicides and fear of toxic residue coupled with the lack of knowledge about their use.(Ibrahim *etal*,2011)

Although the most desirable strategy is to proactively use annual herbicide rotations, sequential applications, or tank mixtures before resistance evolves, that requires growers to apply multiple herbicides even if weed densities are low. The objective of thisstudy was to investigate the effect of herbicide rotation on growth, yield and yield's components of *Hibiscussabdariffa* in the alley of citrus trees.

MATERIALS AND METHODS

The experimental site was National Horticultural Research Institute (NIHORT) Ibadan. Ibadan the Oyo state capital is located with the coordinates of 07°24, 36.88N, 00351'16.05''E with 213 meters above sea level. Ibadan lies in the derived savannah ecological zone of Nigeria. The treatments consisted of paraquat, glyphosate, metolachlor + hoeing, metolachlor + glyphosate and no weeding as control. Roselle seeds were planted in the alley of citrus trees at 60cm x 30 cm spacing, citrus spacing was 5m x 5 m, while the plot size was 6m x 3m.Data collected includes growth attributes of citrus trees, roselle growth and yield attributes at 1m, 2m and 3m distance away from citrus tree and weed biomass. The experimental design wasRandomized Complete Block Design (RCBD) in four replications. The data collected were subjected to analysis of variance (ANOVA) using SAS analysis and means were separated by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Table 1 shows the roselle fruit yield at 1m, 2m, and 3m distances away from the citrus trees. Significantly ($P<0.05$) highest number of fruit was recorded from plots treated with glyphosate at 1m spacing, while the least number of fruit was recorded from the check(no weeding plots). At 2m and 3m distance away from citrus trees, highest number of fruit (20.0and 30.0) was also recorded from glyphosate treated plots but not significantly different from other treatments (Table 1). The result on calyx dry weight shows that significantly

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($p<0.05$) higher fruit weight (17.8 and 19.8 g/m^2) was also recorded from plots treated withglyphosate at 1m and 2m distance respectively. However at 3m distanceaway from citrus trees, highest calyx dry weight was recorded from paraquat treated plots and closely followed by glyphosate and metolachlor + hoeing plots. These were not significantly different from other treatments and the weedy check 1 (no weeding). Tallest plant (260.7cm) was recorded from plots treated with metolachlor + glyphosate, but was not significantly different from other treatments. A significantly wider diameter (9.8cm) was recorded from the weedy check (no weeding) but was not significantly different from herbicide rotated plots. Similar trend was also observed for scion diameter (7.6cm) in no weeding plots. The canopy spreads as observed also revealed that no weeding plots and metolachlor + glyphosate plots recorded highest canopy spreads at CS 1 and CS 2, these were not significantly different from other treatment except paraquat treated plots at CS 1 (Table2).The response of roselle in citrus alley viewed at different distances, confirms the report of the preliminary study of Oyedele *et al.* (2015). Highest calyx yield was produced at 3 m distance from the citrus tree, which was not significantly different from the yield obtained from other treatments, this confirms the result of the earlier work of Olaniyan and Fagbayide (2005), who reported that intercropping did not hinder the optimum growth and yield of citrus and companion crops. The least dry weight of 15.0g/m^2 was recorded from paraquat treated plots, this was significantly lower when compared with other treatments except no weeding plots. While significantly ($P<0.05$) highest weed dry weight was recorded from metolachlor + glyphosate plots (Table 2).This result may also be attributed to vigorous plant with loss competition for light, nutrients, and free space in weed from environment (Ahmed and Salahudeen, 2010).

CONCLUSION

In this study, there was similarity in the efficacy of the two herbicides and its rotation; this shows that the efficacy was more influenced by the nature of their active ingredients. The rotation of the herbicide and combination with hoeing enhanced the yield of roselle and growth of the citrus trees. Also, the highest calyx yield observed at 3m away from the citrus is an indication of non-tolerance of roselle plant to shade.

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Table 1. Effect of herbicide rotation on number of fruit and calyx dry weight of roselle in citrus alley

	Roselle Fruit Yield			Calyx Dry Weight		
Treatments	**1m**	**2m**	**3m**	**1m**	**2m**	**3m**
Paraquat	8.3bc	19.3a	29.0a	6.5c	16.4ab	22.0a
Glyphosate	17.7a	20.0a	30.0a	17.8a	19.8a	21.1a
Metolachlor+ hoeing	13.3ab	17.7a	27.7a	13.7ab	11.3b	21.1a
Metolachlor+ glyphosate	8.7bc	23.7a	26.7a	8.3ab	12.8ab	15.2a
No weeding	5.3c	17.7a	19.6a	9.6bc	16.1ab	16.3a

Means followed by the same letter(s) in the same column are not significantly different from each other.

Table 2. Effect of herbicide rotation on growth attributes of citrus trees and weed dry weight

		Citrus growth attributes				
Treatments	PH	CD	SD	CS 1	CS 2	Weed dry weight (g/m^2)
Paraquat	228.3a	6.4b	4.3b	144.3b	180.3a	15.0c
Glyphosate	198.0a	6.7b	4.3b	207.3ab	196.7a	39.0a
Metolachlor+ hoeing	243.7a	7.3ab	5.0b	240.0a	173.7a	37.3ab
Metolachlor+ glyphosate	260.7a	8.4ab	6.1ab	277.0a	266.7a	53.7a
No weeding	240.3a	9.8a	7.6a	277.7a	196.3a	20.0bc

Means followed by the same letter(s) in the same column are not significantly different from each other

PH –Plant Height , CD – Collar Diameter, CS – Canopy Spread

Effect of Planting Date on the Performances of Sunflower *(Helianthus anuus* L.) Varieties in Lafia

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Abstract

The experiments were conducted during 2016 and2017 rainy season; to determine a befitting planting date and the best variety of sunflower to be planted in Southern Guinea Savanna agro ecological zone of Nigeria. The treatments consisted of three planting dates (15 June, 29 June, 13 July) and three varieties (Samsun-3, Samsun-4, Samsun-5) which were factorially combined and laid in a Randomized Complete Block Design (RCBD) and replicated three times. The results showed thatplanting date and sunflower varieties significantly increased seedling emergence. Planting at June 29 had the highest percent seedling emergence of 86.82% and 91.36% in both years; this is at par with planting date of July 13 in 2016 and 2017 cropping season. Samsun – 4 variety of sunflower recorded the best seedling emergence percentage of 81.01% and 86.26%; which is higher than the other varieties tested in both years of cropping.Planting dates had a significant increased on all the vegetative growth parameters of sunflower assessed in both years of cropping. Planting on June 29, produced sunflowers with highest number of 16. 79 and 17.91leaves; tallest sunflower plant of 55.49 and 56.78cm in height; and biggest stem girth of 2.82 and 2.78cm in both years of cropping. However, all the varieties tested did not showed any significant increase on the vegetative parameters of sunflower.Planting date of 29 June recorded significantlythe highest seed yield of 659.24 and 678.24 kg ha^{-1}in both years of cropping. Sunflower varieties on the other hand showed significant increased on only head weight per plant, seed weight per head of sunflower, and seed yield kgha^{-1}. Samsun – 3 demonstrated its superiority in terms of the heaviest heads (104.82 and 143.37g), seed weight per head (29.32 and 29.24g) and total seed yield of 572.45and 570.86kgha^{-1} in both years of cropping sunflower.Planting sunflower after June 29 may not produce optimally in seeds yield and Samsun -3 variety showed better quality, but were not significantly different from the other varieties.

***Keywords**: Planting date, variety, vegetative growth, Sunflower, Southern Guinea Savanna*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) occupies the fourth position among vegetable oilseeds after soybean, oil palm and canola in the world (Ahmad *et al.,* 2011). Although sunflower is generally regarded as a temperate crop, it is currently cultivated on approximately 23 million hectares in 40 countries of the world, including some countries in the humid tropical Africa; because the plant is quite rustic and can perform well under varying climatic and soil conditions (Seiler *et al.,* 2008). The major goal of growing sunflower is for its seed that contains oil (36–52%) and protein (28–32%) as reported by Rosa *et al.,* (2009). Planting dates have great influence on vegetative, generative growth and yield of sunflower (Ahmed *et al.,* 2015). The late planting is effective in delaying of emergence,

flowering, and maturity in some cultivars of sunflower. However, in studies that were conducted in different ecological and climatic conditions, the planting date delayed the growth, reduced the seed yield and quality (oil content) generally(Baghdadi et al., 2014). Ali et al., (2014) observed that the yield and agronomical characteristics of sunflower were notably higher in the early sown crops whereas the late sown crops showed lower yield and growth. In addition, the seed yield, head diameter, the ratio of dehulled/hulled seed weight, 1000 seed weight, oil content of seedsare positively affected by early sowing of sunflower (Abdou*et al.,* 2011)Therefore, to enhance sunflower growth and yield , it is

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necessary to take intoconsideration the optimum planting date for achieving higher yield.Optimum sowing date of sunflower as early and late season crops is relatively well known to be late May and July – Early August, respectively in the forest–savanna transition zone (Ogunemi, 2000). However, in southern guinea savanna zone; there is still a dearth of documented information on planting date of sunflower. This study therefore seek to investigate the optimum planting date and suitable variety of sunflower in this zone.

MATERIAL AND METHODS

Climate Conditions

The experiments were conducted during 2016 and2017 rainy season at the research and teachingfarm of the college of agriculture, Lafia, Nasarawa state, Nigeria. The study area fallswithin southern guinea savanna agroecological zone of Nigeria, and is located between Latitude08.33 N and Longitude 08.32 E. Rainfall usually starts from May – October and the averagemonthly rainfall figures ranges from 400 -350mm. The months of July and August usuallyrecords heavy rainfall. The daily maximumtemperature ranges from 20.0ºC – 38.5ºC anddaily minimum ranges from 18.7ºC – 28.2ºC. Themonths of February to early April are the monthsthat have the highest maximum temperaturewhile the lowest maximum temperature monthsare recorded in December and January becauseof the prevailing cold harmattan wind from the northern part of the country at this period. Therelative humidity rises as from April to amaximum of about 75- 90 percent in July (NIMET, 2017).

Soil and Vegetation Conditions

The soil type of the study area composed of highly leached Alfisols with low base saturation.The soil is strongly acidic and has high content of iron and Aluminium oxides hence reddish brown in colour with very low organic matter contentand low total nitrogen and available phosphate. The vegetation of the study area is that of thesouthern Guinea Savanna with interspersion ofthicket, grassland, trees, fringing woodlands orgallery forest along the streams. The naturalvegetation of the area is made up of grasses andsome traces of scattered wild and economictrees like *Vittellariaparadoxa* (Shear butter tree); *Parkia*spp (locust bean tree); *Gmelina*arborea (beechwood); *Anacadium*spp (Cashew trees); *Magniferaindica* (Mango). These trees usuallyshed off their leaves in the long dry season toconserve the available water.

Experimental Design and DataCollection

The treatments consisted of planting dates (15 June, 29 June, 13 July), threevarieties (samsun-3, samsun-4, samsun-5) which were factorially combined and laid in a Randomized Complete Block Design (RCBD) and replicated three times to form thirty six plots. The plot size was 3 m by 4 m plots and 0.5 m between plots. The soil data for this study were collected from soil samples at the depth of 20 cm from experimental plots before planting for analysis. The land was cleared, ploughed and harrowed. Sunflower seeds were obtained from I.A.R (ABU Zaria) and he urea fertilizer was purchased from Nasarawa state agricultural development program (N.A.D.P). Weeds were control by hand hoeingand insect pest were controlled using sprayed with karate 5EC. The following parameters [% Seedling emergence, plant height, stem girth, number of leaves, days to first flowering, days to maturity, head weight, head diameter, seed weight per head and seed weight per hectare] were assessed in both years.

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Data analysis

The data collected weresubjected to analysis of variance using GENSTAT, and where there is a significantdifference; the means were separated using F-LSD at 5% probability level.

RESULTS

Soil and Manure Analysis

The soil of the experimental site was low in most of the plant nutrient elements, implying that the soil is low in fertility(Table 1). Also, the soil was slightly acidic in nature (6.08, 6.10); high in sand fraction (85.00, 84.00) and also very high in base saturation (87.00, 90.39) in both 2016 and 2017 cropping seasons.

Effect of Planting dates and Varieties on Sunflower Seedling Emergence

The result showed that planting dates and sunflower varieties had a significant effect on seedling emergence of sunflower (Table 1) in both years of cropping. The seeds that were planted on June 29 had the highest percent seedling emergence of 86.82% and 91.36%; this result is at par with planting date of July 13 in 2016 and 2017 cropping season. Samsun – 4 variety of sunflower recorded the best seedling emergence percentage of 81.01% and 86.26%; which is higher than the other varieties tested in both 2016 and 2017 cropping season

Effect of Planting dates and Varieties on Vegetative Growth of Sunflower

Planting dates had a significant effects on all the vegetative growth parameters of sunflower assessed in both years of cropping (Table 2). Planting on June 29, produced sunflowers with highest number of 16. 79 and 17.91leaves; tallest sunflower plant of 55.49cm and 56.78cm in height; and biggest stem girth of 2.82cm and 2.78cm in both years of cropping. However, all the varieties tested do not showed significant effect on the vegetative parameters except on the stem girth where samsun -3 variety produced the biggest stem girth compared to the other varieties in both years of cropping.

Effect of Planting dates and Varieties on Yield Parameter of Sunflower

The result in (Table 3), showed that planting date had a significant increased on days to maturity, head weight, seed weight per head and seed yield per kg/ha of sunflower; but was not significant to days to 1st flowering and head diameter. July 13 planting date recorded the earliest maturity days of 83.91 and 84.78days in both cropping season which is at par with Jun 29 planting date. Also June 29 planting date recorded the biggest head diameter of 18.12 cm and 19.18cm; heaviest head weight of 203.13g and 216.34g per plant; highest seed weight per plant and the highest seed yield of 659.24 kg ha^{-1} and 678.24 kg ha^{-1}in both years of cropping. Sunflower varieties on the hand showed significant increased on only head weight per plant, seed weight per head of sunflower, and seed yield kgha^{-1}. Samsun – 3 demonstrated its superiority in terms of the heaviest heads (104.82g and 143.37g), seed weight (29.32g and 29.24g) and total seed yield of 572.45kgha^{-1} and 570.86kgha^{-1} in both years of cropping sunflower.

DISCUSSION

The significant response of sunflower seedling emergence to planting dates may be attributed to availability of adequate soil moisture and required temperature that enhances the germination processes. Also, the vigorous vegetative growth (Plant height, number of leaves and stem girth) of sunflower during the early planting dates could be explained by application of adequate fertilizer and availability of soil moisture, which enabled roots to absorb enough nutrients for plant growth. This result is in line with the report of Lawal*et*

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al., (2011) who observed that earlier application of fertilizer and adequatesoil moisture aids nutrient absorption which may result to good growth response of sunflower varieties. Planting date exerted significant influenceon all the yield parameters assessed except days to first flowering, whilevarieties did not showed significant difference in both planting season; withthe second year cropping showing much improvement compared with first year cropping (Table 3).Sunflower that were planted earlier performed better in most of the yield parameters (head weight/plant, head diameter, head seed weight/plant, seed weight $kgha^{-1}$). The luxuriant growth ofsunflower that were planted late did not translate to seed production as rain has stopped during their seed filling stage of growth. Whereas, those planted early had their seed filling stage with adequate moisture compared with those planted late. This underscore the relevance of adequate supply of water for good seed production. This is in consonance with the report of Allam*et al.,* (2003). Also, the heads of thosesunflowers planted late were smaller with tiny seeds and majority of their achenes toward the centre of the head were hollow; therefore blown away during winnowing. This explains why the late planted sunflowers had large head diameters comparable to the earlier planted but recorded fewer seeds.

CONCLUSSION

From this study, it can be concluded that planting sunflower in southern guinea savanna of Nigeria after June 29 may not produce optimally, especially in commercial production. Also, Samsun -3 showed better quality, but were not significantly different from the other varieties.

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Table 1: Laboratory analysis of soils at 0-30cm before cropping in both years

Properties	2016	2017
Mech. Composition		
Clay (%)	11.6	12.6
Silt	3.4	3.4
Sand	85.0	84.0
TCL (USD)	SL	SL
Chemical composition		
pH(H2O)	6.08	6.10
pH(0.01MKCl2)	6.00	5.44
T N%	0.04	0.07
% OC	0.64	0.86
% O M	1.10	1.48
Avail. P(ppm)	4.57	12.29
K(mgkg^{-1})	0.31	0.38
Mg(cmolkg^{-1})	1.78	1.28
Ca(cmolkg^{-1})	3.41	4.83
Na(cmolkg^{-1})	0.67	0.42
Al + H(acidity)	0.83	0.76
CEC(cmolkg^{-1})	6.17	7.91
%Base Saturation	87.00	90.39

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Table 2: Planting date and Varieties on sunflower seedling emergence

Treatment	% Seedling emergence	
	2016	2017
Planting dates		
June 15	42.91	62.59
June 29	86.82	91.36
July 13	81.64	85.42
LSD(0.05)	9.02	12.26
Varieties		
Samsun – 3	68.02	69.25
Samsun – 4	81.01	86.26
Samsun – 5	67.42	71.54
LSD(0.05)	7.81	5.14

Table 3: Effect of planting dates and varieties on the growth parameters of sunflower at seven weeks after planting

Treatment	Number of leaves		Plant height (cm)		Stem girth(cm)	
	2016	2017	2016	2017	2016	2017
Planting dates						
June 15	14.28	15.23	53.24	54.13	3.12	3.14
June 29	16.79	17.91	55.49	56.78	2.82	2.78
July 13	13.83	14.26	52.26	51.48	2.36	2.14
LSD(0.05)	2.18	2.12	1.18	1.24	0.12	0.24
Varieties						
Samsun – 3	15.45	15.23	57.14	56.97	3.14	3.21
Samsun – 4	16.12	15.48	56.45	57.10	2.22	2.42
Samsun – 5	15.74	16.02	56.67	56.78	2.35	2.56
LSD(0.05)	1.86	1.54	1.89	1.85	0.18	0.22

Table 4: Effect of planting date and varieties on yield parameters of sunflower

Treatment	Days to 1st flower		Days to maturity		Head diameter(cm)		Headwt/plant(g)		Seedwt/ Head(g)		Seed yield(kg/ha)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Planting dates												
June 15	51.02	50.16	90.92	91.24	16.04	16.86	156.32	168.54	31.43	33.23	574.35	589.86
June 29	47.95	48.34	84.03	85.42	18.12	19.18	203.13	216.34	39.72	41.34	659.24	678.35
July 13	48.14	48.56	83.91	84.78	16.12	17.85	105.61	122.21	25.62	25.75	505.35	515.12
LSD(0.05)	Ns	ns	1.07	1.13	2.96	2.95	35.74	34.23	4.32	5.24	65.43	68.65
Varieties												
Samsun – 3	49.92	48.75	85.42	86.17	14.71	15.23	140.82	143.37	29.32	29.24	572.45	570.86
Samsun – 4	47.83	49.42	84.91	85.21	13.42	14.12	102.11	100.49	22.23	23.09	528.05	530.12
Samsun – 5	49.25	48.67	85.32	85.23	14.15	14.21	130.42	133.46	29.21	29.11	544.12	546.53
LSD(0.05)	ns	ns	ns	ns	ns	ns	34.43	30.56	4.24	3.45	56.74	59.45

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Nutritional Efficacy of two Plant Extracts as Foliar Application on the Yield and Yield Components of Okra (*Abelmoschus esculentus* (l.) Moench), in Sub-humid Region of Nigeria

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Abstract
Field experiment was conducted at the Inland Valley (Fadama) Teaching and Research Farm of Faculty of Agriculture, Federal University Oye-Ekiti (Ikole Campus), Ekiti State from December 2016 to March 2017to evaluate the effect of foliar spraying of plant extracts as nutrient sources on the yield and yield component of okra. The experiment was arranged in a randomized complete block design (RCBD) with three replications. The trial consists of eight treatments of 10, 15 and 20 g of dry Neem leaf (powder); 10, 15 and 20g of dry Bitter leaf (powder), NPK 15:15:15 (treated check) and control(no fertilization).The results obtained showed that there were significant differences ($p<0.05$) in the plant height among all the treatments combinations. Okra that was sprayed with neem leaf extract with 20g concentration produced highest plant height (39.74 cm). Number of days to first flowering and 50% flowering were significantly ($p<0.05$) influenced by neem extract at 10 – 20g concentrations and the bitter leaf with 10g and 15g concentrations. Neem extract with 20g and bitter leaf with 10g and 15g concentrations had significant ($p<0.05$) effect on yield component of okra. The foliar application of Neem and bitter leave plant extract with 20g concentrations significantly produced the best yield (164.02g).
Keywords: Okra, sustainable, organic sources, application rate

INTRODUCTION

Okra (*Abelmoschus esculentus* L.Moench) has been reported as one of the most popularly home grown and consumed vegetables in the world both in tropical and subtropical regions(Senjobi et al 2013) it is also an important vegetable in Nigeria.Okra is cultivated for its fruits or pods, the tender fruits, leaves and succulent shoots are harvested when immature and consumed as a vegetable, either in fresh or dried forms for nutrient (Arapitsas, 2008). In Nigeria, okra is ranked third in relation to consumption and production area, following tomato and pepper (Ibeawuchi, 2007).According to Onunkun (2012) among the problems of okra production in Nigeria is the poor frequent use of inorganic fertilizer which has been found to increase the acidity of soil that adversely affect crop and microbiological properties of the soil. Also the high cost of importing inorganic fertilizers which have further aggravated the local currency devaluation, not only creates a serious drain on the economy of the countries like Nigeria but has made such fertilizers unaffordable to resource poor farmers (Alphonsus *et al.*,2005).

Considering the above mentioned fact, locally available and economically sustainable products and crop production strategies are now being explored to improve farmers yield and a productive environment. Nutrient supply as foliar through plant extracts which is a form of organic manure will not only reduce the dependence on chemical fertilizers but also encourage the growth, alleviate the deficiency of macro and micro nutrients and sustain higher productivity (Tiwari, 2002; Singh *et al.*, 2006).Further research efforts aimed at reducing the problems of using inorganic fertilizers led to the development and use of extracts from plants leaves. However, some of these

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plant extracts have been used for the management of insect pests control in vegetable production (Mallick 2005; Moyin-Jesu,2010). There is however, dearth of information on the use of neem leaves (*Azadiractha indica*) and bitter leaves (*Vernonia amygdalina*) extracts for use as nutrient supplement for the production of vegetables.This research work is therefore, aimed at identifying the best plant extracts and the appropriate concentration that can serve as foliar application for nutrient sources for increasing the yield and yield component of okra.

MATERIALS AND METHODS

Location and site characterization

The experiment was carried out from December 2016 to March 2017 at the Inland valley (Fadama) Teaching and Research Farm of Faculty of Agriculture, Federal University Oye-Ekiti (Ikole Campus), Ekiti State, Nigeria..Soil sample was taken at a depth of 0-15cm with a soil auger for routine analysis of the physical and chemical properties.

Procedure for forming plants extracts solution

a) Collection / Harvesting of plant leave samples (neem and bitter leaves).
b) Drying of leaves was done at room temperature (air drying) for 4 weeks.
c) Grinding of both leaves into powder was done using an electronic blender in the laboratory.
d) Filtering of the grounded samples was done using 425mic sieve.
e) Weighing of each sample at 10, 15 and 20g was done using a sensitive weighing balance.
f) Soaking of 10, 15, and 20g of each of the sample into 90, 85 and 80ml of water respectively for 24hrs.
g) Filtering each of the solution was done using 125mic sieve to obtain clean leaf extracts.
h) A hand sprayer was used in spraying the obtained clean leaf extract on the crop

The powdery form of both the neem and bitter leaf were taken to the lab for analysis as the results of the plant extracts analysis shows that the percentage compositions of both the macro and micro nutrients were higher except Calcium and Magnesium in bitter extract than neem extract. The percentage of nitrogen was 4.60% in bitter leaves extract and 2.79% in neem leaves extract, phosphorus was 0.37% in bitter leaves extract and 0.18% in neem while the Potassium was 0.93 in neem extract and 2.18% in bitter leaves (Table 2).

Experimental design and treatments

Okra(NHAe 47 – 4 variety) was obtained from NIHORT, Ibadan and was sown on a plot measuring 4 x 3 m (12 m^2). The okra seeds were planted at an inter/intra row spacing of 50x30cm with a total population of 66,666 plants/ha.The experiment was laid out in a randomized complete block design (RCBD) with three (3) replicates.The trial consists of applications 10, 15 and 20g of Neem and Bitter leavesaqueous extracts soaked in 100 ml of water with application of NPK 15:15:15 as a treated check control(no fertilizer application).The plant extracts were appliedat the different concentrations commencing from three weeks after sowing (WAS) and at two weeks interval till harvesting.

Plant sampling and data collection

Five plants were randomly selected and tagged from each plot for measuring the growth parameters at 3, 5, 7 and 9 weeks after sowing planting (WAS). Other parameters collected from the trial

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includedyield and yield components of the crops.

Data analysis

Data collected on growth and yield parameters were subjected to Analysis of Variance (ANOVA) using GENSTAT (General Statistics) (12th Edition input year). Significant means of the treatments were separated using Duncan Multiple Range Test (DMRT).

RESULTS

Effects of plants extract concentrations on growth of okra

Across all the sampling periods (3 – 9WAS) plant heights of okra (cm) significantly ($p<0.05$) differed among the two plant extracts used at their various concentrations. Neem leaf at 20 g concentration consistently had significantly ($p<0.05$) taller plant height (39.74 cm) while the control had the shortest plant (27.95 cm) (Table 3).There was no significant ($p<0.05$) different among the treatments at 3WAS. Neem leaf at 15 and 20 g produced the highest number of leaf at 7 – 9WAS. Amongst all, Neem leaf at 20 g produced the highest number of leaves across the sampling periods (16.86) (Table 3).

Table 4 shows that the leaf lengths of okra were significantly ($p<0.05$) influenced by plant extracts as they were observed to be different from each other throughout the sampling periods. Neem leaf at 20g concentration consistently influenced the increase in length of leaves across the observation periods and the smallest leaf length was recorded from the control plot (8.05 cm).Also from Table 4 significant differences were observed among the extracts at their various concentrations on leaf breath at 3WAS. The three levels of neem leaf (10, 15, and 20g concentrations) and bitter leaf at 10g showed significantly ($p<0.05$) different influence on the breath of leaves from other concentrations as neem leaf at 15g produces the widest leaves at 5WAS (13.9cm) while at 7WAS and 9WAS neem leaf led to the production of the widest leaves (21.3 and 26.5cm) at 20g of concentration.

Table 5 shows that there was no significant ($p<0.05$) effect among the extracts at their various concentrations and also the application of insecticide and control at 3WAS. Neem leaf at 20g was seen to significantly increase stem girth of okra at 5WAS while the bitter leaf extract was observed to produce the biggest plant diameter (stem girth) at 7 and 9 WAS (4.1 and 4.90cm).The level of significant effects of the plant extracts on the number of branches of okra across the observation periods are shown in Table 5 as bitter leaf plant extract at 10g concentration was observed to have had highly significant effect throughout the observation periods while the control gave the least. At 5WAS neem plant extract used at 15and 20g and the bitter leaf used at 10g concentrations were significantly ($p<0.05$) different from other concentrations. While at 7WAS the bitter leaf plant extract at 10g concentration increased the production of branches thereby producing the highest number of branches (3.60) and at 9WAS neem plant extract at 20g and the bitter leaf at 10g produced the highest number of branches (4.56 and 4.66).

Effects of plants extract concentrations on yield and yield parameters of okra

The plant extracts used at 10, 15, 20g concentrations of neem leaf and 10 and 15g concentrations of bitter leaf were significantly ($p<0.05$) different from each other on the number of days to first flowering. Also there was no significant difference between the bitter leaf plant extract at 20g and the NPK treated plant but the control which flowered late at 43days was significantly lower from all the treatment combinations (Table 6). The results in Table 6 shows the level of significant differences in the number of days to 50% of flowering in okra as influenced by the various concentrations of plant extracts. At 10g concentration of bitter leaf plant extract, 50% flowering occurred as early as 41days followed by neem plant extracts at 10 and 20g, respectively. Also, 20g concentration of bitter leaf extract and control were not significantly different from each other as they attained 50% flowering late at 44, 45, 45 days, respectively. The effect of the plant extracts was significant on the number of flowers formed per plant as neem extract at 20g and bitter leaf plant extract at 20g concentrations were seen to produce significantly higher number of flowers (12) and the control produces lower number of flowers (7) (Table 6).There were significant effect of plant extract on the yield and yield component of okra at various plant concentrations. The highest number of fruits per plant was recorded at 20g concentration of neem extract (11) and the lowest was from the control plot (8) (Table 6).Neem extract at 20 and bitter leaf at 10 and 15g of concentrations had significant effect on fresh weight of fruits per plant and were highly significantly different from all other treatment combinations. Also 10g of bitter leaf plant extract application produced the heaviest fruit weight at 20.00g per plant as the control plot produced the lowest fruit fresh weight at 17.46g per plant (Table 6).Plant extracts at different concentration levels had significant effect on fruit length as well (Table 6). Neem plant extract at 20g was shown to have had significant effect on length of fruits produced (5.03cm) compared to the control (3.5cm).Bitter leaf extracts at three concentration levels had significant effect on fruit girth of okra and were significantly different from all other treatment combinations. Also neem extract at 10, 15 and 20g and the check were not significantly different from each other but were significantly higher than the fruits girth obtained at the control plot (Table 6).Plant extracts at different concentration levels had significant effect on fresh weight of okra from net plot (Table 6). Neem and bitter leave plant extract at 20g of concentrations significantly increased the yield (164.02 g/plot and 163.65g/plot), as its yield was higher than the yields of other plant extract concentration. The lowest weight was obtained from the control plot (152.48g/plot).

DISCUSSION

The soil analysis showed that the soil is sandy loam, it is also an acidic soil whose pH level is 5.8. Udoh *et al.*(2005) refers to this type of soil as a low fertile soil as the organic matter content, available K, and P are low. Generally, growth characters such as plant height, number of leaves, length and breadth of leaves and stem diameter increased with time. This may be connected with the fact that photosynthesis and the ability of the photosynthesis path to accumulate photosynthate increased with time (Park 2009.). Yield characters such as number of flowers formed per plant, number of fruit per plant, fruit length, fruit weight and fruit diameter varies significantly with each treatment. From the observation, the treatment with neem aqueous extract at 20g of concentration produced the highest yield. The result agrees with the findings of Subbalakshmi (2012) that Neem application on crops helps to increase the yield. Neem extract has been noted to posses high insecticidal properties (Khan *et al* 1991), its use in the present study may have conferred some immunity on the crop thus preventing yield loss as this may have in turn supported the better productivity and yield of the crop. The

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application of various extracts produced significant effect on the performance of okra when compared with the Check and the control treatment. All the parameters taken were positively influenced by the application of the plant extracts at their various concentrations. The plant height treated neem extract at 20g of concentration was the tallest plant. This may be due to the presence of possible growth hormones in the appropriate amount in Neem (Kasarkar and Barge, 2016). Other growth parameters like the number of leaves, length and breadth of leaves and the number of branches appreciably increased with application of plant extracts than the inorganic fertilizer and the control plots. This finding is in agreement with (Akande *et al.,* 2010 and Ajari *et al.,* 2003) who reported that application of organic base fertilizers enhanced plant growth and development.

The length to maturity can be deduced from the number of days to first flowering and days to 50% flowering, which can be indicated from the result that the treatment with neem extract at 10 – 20 g of concentrations and the bitter leaf at 10 and 15g of concentrations among others had the highest number of days to first and 50% flowering while the bitter leaf at 20g, the inorganic fertilizer and the control had the lowest number of days to first and 50% flowering. This observation was supported by Mallick (2005) who reported superior performance of plant extracts on flower formation. Nevertheless, the significant effect of extracts on the number of flowers, fruits and weight of fruits could be attributed to the macro and micro nutrients in the plant extract as Adeniyan and Oyeniyi (2005) reports the importance of these elements. This also corroborate with the findings of Akande *et al.*(2010) that plant extracts as organic manure helps to improve the quality of plant, thereby enhancing the growth of plants and fruits. Their findings were also in line with the work of Akande *et al*., 2010 who attributed higher growth and development in okra to application of organic manure, though this was not as foliar application.The poor growth and yield performance of okra in the control treatment was consistent with the fact that the soil was very low in nutrient contents. This observation was supported by Arapitsas (2008) who had reported poor growth and yield responses of crops in unfertilized soil.

CONCLUSION

The study revealed the potentials of the foliar application of aqueous plant extracts as nutrient source. The use of neem and bitter leaf aqueous extracts is a way to organic farming and an attempt to sustainable agriculture with less threat on the environment. The results obtained from this study showed that neem and bitter leaf aqueous extracts at 20gconcentrations both increase the yield of okra.

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Table 1: Physico-Chemical Properties of the soil of the experimental site

Parameters	Units	Soil
pH(in water, 1:2.5)	1:2.5	5.8
organic matter	%	2.20
Total nitrogen	%	0.25
Available phosphorus (Bray method)	*Ppm*	6.20
	Exchangeable	
- Potassium (K)	$Cmolkg^{-1}$	1.69
- Sodium (Na)	$Cmolkg^{-1}$	0.10
- Calcium (Ca)	$Cmolkg^{-1}$	8.56
- Magnesium (Mg)	$Cmolkg^{-1}$	0.94
ECEC		11.29
Zinc (Zn.)	*Ppm*	9.74
Copper (Cu.)	*Ppm*	4.66
Manganese (Mn.)	*ppm*	263.69
Iron (Fe.)	*ppm*	104.15
	Particle size	
- Sand	%	68
- Clay	%	19
- Silt	%	13
Textural class	-	Sandy loam

Table 2: Physico-Chemical Properties of plant extracts

Parameters	Units	Neem Leaves	Bitter leaves
Nitrogen (N)	%	2.79	4.60
Phosphorus (P)	%	0.18	0.37
Calcium (Ca)	%	2.73	1.71
Magnesium (Mg)	%	0.32	0.29
Potassium (K)	%	0.93	2.18
Sodium (Na)	*ppm*	51.85	68.51
Zinc (Zn)	*ppm*	19.44	56.97
Copper (Cu)	*ppm*	4.76	9.58
Manganese (Mn)	*ppm*	41.52	247.44
Iron (Fe)	*ppm*	20.52	27.20

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Table 3: Effects of plant extracts on plant height and number of leaves of okra

	Plant height (cm)				Number of leaves			
Treatment	3WAS	5WAS	7WAS	9WAS	3WAS	5WAS	7WAS	9WAS
NL10	7.4ab	16.12ab	27.13a	37.84ab	4.33a	7.64ab	14.91abc	15.72ab
NL15	8.45a	17.0ab	28.24a	38.61a	4.48a	7.63ab	15.84a	16.60a
NL20	8.81a	19.39a	28.77a	39.74a	4.66a	7.88a	16.05a	16.86a
BL10	8.97a	12ab	27.32a	36.72abc	4.67a	7.20bc	15.27ab	15.22bc
BL15	8.62a	18.10ab	27.68a	33.14cd	4.80a	7.56ab	15.14abc	14.74bc
BL20	7.17ab	16.74ab	24.98ab	33.76bcd	4.63a	6.73cd	14.07bc	14.31c
NPK	7.35ab	15.73bc	24.47ab	30.56de	4.60a	6.98c	13.82c	14.23c
Control	5.0b	12.85c	22.30b	27.95e	4.23a	6.26d	12.14d	12.38d

Means with the same letters are not significantly different at 5% level of probability across the column.
Weeks After Sowing =WAS,
NL= Neem Leaf,
BL=Bitter Leaf

Table 4: Effects of plant extracts on the length and breadth of okra leaves

	Leaf Length (cm)				Leaf Breadth (cm)			
Treatment	3WAS	5WAS	7WAS	9WAS	3WAS	5WAS	7WAS	9WAS
NL10	4.97bc	12.35ab	19.02ab	22.92ab	8.46ab	13.61a	20.76a	24.40b
NL15	5.00bc	12.08ab	19.0ab	22.89ab	9.23ab	13.93a	20.99a	24.73ab
NL20	7.01a	13.01a	20.03a	23.92a	10.38a	13.91a	21.34a	26.58a
BL10	6.68ab	11.38bc	18.16bc	24.27ab	7.44bc	13.11a	19.36ab	23.90bc
BL15	6.47ab	10.33c	17.15c	21.89ab	8.17ab	11.33b	18.57b	22.13cd
BL20	6.32abc	9.85c	16.72c	21.50b	8.57ab	10.81b	18.25b	21.61de
NPK	5.89abc	10.12c	17.15c	21.63b	6.77bc	11.60b	18.50b	22.40cd
Control	4.63c	8.05d	14.66d	19.16c	5.02c	9.07c	15.82c	19.87e

Means with the same letter are not significantly different at 5% level of probability across the column.
Weeks After Sowing =WAS,
NL= Neem Leaf,
BL=Bitter Leaf

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Table 5: Effects of plant extracts on stem girth (diameter) and numbers of branches of okra plant.

	Stem Girth (cm)				Numbers of Branches		
Treatment	**3WAS**	**5WAS**	**7WAS**	**9WAS**	**5WAS**	**7WAS**	**9WAS**
NL10	1.11a	2.28ab	3.82abc	4.63abc	1.70ab	2.68bc	3.06c
NL15	1.17a	2.37ab	3.40bcd	4.20bcd	2.06a	2.26cd	3.86b
NL20	1.25a	2.84a	3.86ab	4.66ab	2.28a	3.14ab	4.56a
BL10	1.34a	2.44ab	4.1a	4.90a	2.04a	3.60a	4.66a
BL15	0.8a	2.16abc	3.60bcd	4.40bcd	1.68ab	2.67bc	4.19ab
BL20	1.11a	1.83bc	3.64abc	4.40bcd	1.70ab	2.71bc	4.34ab
NPK	1.13a	1.86bc	3.36cd	4.17cd	1.20bc	2.02cd	3.27c
Control	1.10a	1.55c	3.15d	4.01d	0.86c	1.78d	2.79c

Means with the same letter are not significantly different at 5% level of probability across the column.
Weeks After Sowing =WAS,
NL= Neem Leaf,
BL=BitterLeaf

Table 6: Effects of plant extracts on yield and yield parameters of okra plant.

Treatment	Days to first flower	Days to 50% flower	Number of flower /plant	Number of fruit/ plant	Fruit fresh weight/ plant (g)	Fruit length (cm)	Fruit Girth (cm)	Fresh fruit weight yield/plot (g)
NL10	38.00b	42.33ab	10.00ab	9.44ab	18.89c	4.63ab	2.03ab	156.27bc
NL15	37.33b	42.33ab	10.00ab	9.60ab	19.18b	4.90ab	2.03ab	157.26abc
NL20	39.00b	42.33ab	12.00a	10.64a	19.91a	5.03a	2.20ab	164.02a
BL10	36.66b	41.00b	9.00b	8.92abc	20.00a	4.80ab	2.30a	160.80ab
BL15	37.00b	42.66ab	10.00ab	8.64bc	19.90a	4.03bc	2.33a	159.44ab
BL20	39.33ab	44.00a	12.00a	9.60ab	19.13b	4.76ab	2.40a	163.65a
NPK	39.00ab	45.00a	10.00ab	8.00bc	18.20d	4.56ab	2.23ab	156.25bc
Control	43.00a	45.00a	7.00c	7.6c	17.46e	3.56c	1.83b	152.48c

Means with the same letter are not significantly different at 5% level of probability across the column.
NL= Neem Leaf,
BL=Bitter Leaf

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Crop-Weed Relationships in Okra [*Abelmoschus esculentus* (L.) Moench] as Influenced by Duration of Weed Interference in Lafia, Nasarawa State

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Abstract
The experiment carried out at the Teaching and Research Farm (08° 33' N;08° 32'E) of the Faculty of Agriculture, Shabu-Lafia Campus from June to August, 2017 to determine competitiveness of okra under different weed interference duration. Two sets of weed removal treatments were included. In the first treatment set, the crop is kept weed free for 14, 21, 28, 35, 42 and 49 DAE of the crop. The weeds were subsequently allowed to develop till crop harvest. In the second set, weeds were allowed to develop with the crops from emergence until 14, 21, 28, 35, 42 and 49 DAE after crop emergence; then the plots were kept weed-free till harvest and unweeded check. The weed species Hyptis suaveolens, Andropogon gayanus, Digitaria horizontalis occurred throughout the different weed-infested and weed-free interference durations. Cynodon dactylon, Imperata cylindrica, Commelina benghalensis and Acanthospermum hispidum were particularly predominant under increasing weed infestation treatments. The fruit yield of okra under increasing length of weed-free conditions and increased duration of weed infestation ranged from 2.0 to 2.8 tons ha^{-1} and 2.0 to 2.8 tons ha^{-1}, respectively. The point of intersection of yield against length of weed-free period and increasing duration of weed infestation occurred at 35 DAE. The results indicated the period of time in which weed control is necessary to avoid significant yield loss.
Keywords: *Critical Period, Crop–Weed Competition, Weed Dry Weight, Weed Density, Weed Interference, Weed Species Composition*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an annual herb in the family Malvaceae, which is wildly grown vegetable in tropical Asia and sub-Saharan Africa. Okra is commonly planted on a small scale worldwide, with production estimated at 9.62 million tons and 1.83 million ha harvested area in 2014 (FAO, 2016).

Nigeria is the world's second leading producer (13 % of total production), after India (72 %) (FAO, 2011).It high economic attributes has made it valuable as food, and for medicinal purposes. It is rich in human essential nutrients such as polysaccharides, protein, minerals, and vitamins (Santos *et al.,* 2013). The mucilagealsohasindustrial applications as an adhesive and in the manufacture of candy confectioneries. In medicine, mucilage is used as a plasma replacement or blood volume expander, and for cholesterol reduction (Ma *et al.,*1990;Benchasri, 2012).

Weeds continue to have a major impact on crop production despite efforts to manage them. Recently in Nigeria, weed management is relying heavily on the use of herbicides. However, most of the farmers are not familiar with the appropriate time of weed control in order to achieve efficient utilization of resource. One useful tool for determining timing of weed control is the critical period for weed control (CPWC) (Knezevic*et al.* 2002). The CPWC represents the time interval between two separately measured crop–weed interference components: (1) the critical timing of weed removal (CTWR)—the maximum amount of time early-seasonweed competition can be tolerated before signi cant yield reductions occur and This period is defined as the time (growth stages) in the life cycle of a crop plant when weeds must be controlled in order to prevent unacceptable

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yield loss.(2) The critical weed-free period—the minimum weed-free period required from the time of crop planting to prevent yield loss from late-emerging weeds.The rst component was suggested to determine the ''beginning'' of the CPWC, and the latter determines its ''end'' (Knezevic *et al.* 2002). The results from both components are combined to determine the CPWC. Previous research reported that CPWC was affected by nitrogen level in corn (*Zea mays* L.) (Evans *et al.* 2003), and row spacing in soybean (Knezevic*et al.* 2003). The objective of this study was to determine the CTWR for okra as in uenced by timing of weed control.

MATERIALS AND METHOD

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Shabu-Lafia campus (Latitude 08^0 3^0N and Longitude 08^0 32^0E, 161m asl) in Nasarawa State during the 2017 wet cropping season. The experiment was laid out in randomized complete block design (RCBD), with 10 treatments and three replications. The treatments consisted of increasing duration of weed interference, where weeds were kept unweeded preceding hand weeding in the following periods: 7, 14, 21, 28, 35, 42 and 49 days after emergence (DAE)and then increasing length of weed free were kept free from weed interference, by hand weeding in the following periods: 0-7, 0-14, 0-21, 0-28 and 0-35, 0-42 and 0-49 DAE. Weed free and weedy (control) treatments were also included. After these periods, the weeds that emerged will be left to grow freely. Each experimental unit was 3 m wide (consisting of 4 rows spaced 40 cm apart) and 4 m long. Data collection and destructive sampling was done within the centre two rows of each experimental unit with the remaining rows maintained as buffer to eliminate edge effects.

The site was cleared and cultivated manually to a fine tilth. The beds were constructed 2 m x 2 m and each bed was separated by an alley of 1m between replications. Poultry manure was incorporated into the beds two weeks before sowing. Okra seeds - Clemson spineless (NHAe 47-4) was sown at a spacing of 50 cm within rows and 40 cm between rows at three seeds per hole and will be thinned to two per hole at 10 DAE. Two weeks after planting. NPK 15:15:15 was applied at two weeks after planting.

Data were collected on growth and yield parameters; Plant height, number of leaves plant^{-1}, number of branches plant^{-1}number of pods plant^{-1}, Fresh weight pod^{-1}, pod and fruit yield hectare^{-1}. At the end of the harvest weed dry weight and weed population density counts were made within a 25- by 25-cm quadrat at two random locations within each treated plot. Weed control efficiency (WCE) was calculated based on the method suggested by Hasanuzzaman *et al.* (2008).

$$\text{WCE (\%)} - \frac{(\text{DWC}-\text{DWT})}{\text{DWC}} x\ 100$$

Where
DWC =dryweightofweedsinweedycheckplots,
DWT =dryweightofweedsintreatedplots.

RESULTS

Weed species composition

There were 20 different weed species recorded post harvest of okra in which 12were annuals and 8 perennials comprising of 6 grasses, 3 sedges and 10 broadleaf weeds (Table 1). The weed species represented 9 families among which the poaceae family had the highest number of weed species (6). The study identified *Hyptissuaveolens* as the most

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dominant weed species followed by *Imperata cylindrica, Andropogongayanus, Digitariahorizontalis* in descending order of importance. These weeds occurred throughout the different weed-infested and weed-free interference durations.

Effect of weed interference duration on crop performance, weed density, biomass and crop yield

The results revealed that there is no significant difference under increasing and decreasing duration of weed infestation with respect to plant height at 21 DAE(Figure 1) However, at 42 DAE, the weed free regime of 0-28, 0-42 and 0-49 DAE significantly differed from the unweeded control and increasing duration of weed infested plots and had the highest plant height 37.3, 37.0and 36.8 cm, respectively, which did not differed significantly with the weed free treatment. Plant height recorded significant increase with increasing weed free duration at 63 DAE. Similarly, the weed free regime of 0-28, 0-35, 0-42 and 0-49 DAE significantly recorded higher plant height when compared with the unweeded control and increasing duration of weed infested plots.

The number of leaves plant^{-1}was not significant at 21 DAE (Table 2). However, increasing weed free duration produced higher number of leaves plant^{-1}when compared with increasing duration of weed infestation. Conversely, the number of leaves plant^{-1}was significant at 42 and 63 DAE. The trend of observations showed that the highest number of leaves plant^{-1}was recorded in the continual weed free period which was similar to weed free duration up to 42 DAE.

Weed free duration affected significantly the number of branches plant^{-1}at 42 DAE (Table 2). Moreso, there was significant increase in number of branches plant^{-1}at 63 and 84 DAE. The results showed that the weed free duration of 0-21 to 0-49 DAE recorded the highest number of branches plant^{-1}with increasing number of branches plant^{-1}from 5 to 6 branches plant^{-1}when compared with 3 branches plant^{-1}at 63 DAE.

There were significant differences in weed densityweed dry weight and weed control efficiency with respect to weed interference duration. The unweeded check recorded the highest weed density which did not differed significantly with weed infestation duration at 14 DAE. However, both the weed free period and weed interference treatments recorded low and high weed density, respectively (Table 3). Also, the trend of results was similar to weed dry weight. The highest weed dry weight was recorded with the unweeded check, whereas there was significant weed dry weight differences amongst treatments but with weed free interference duration and the latter weed-infestation duration recorded lower weed dry weight. The results also revealed that the weed control efficiency based on the weed dry weight atharvestvariedsignificantlyamongtheweed control treatments (Figure 2).Alltheweedcontroltreatmentsshowed morethan50%WCE,andthe increasing length of weed-free period provided between 60 – 71 % WCE while, similar results were obtained for the long-seasonduration of weed infestation with almost 57 – 77 % WCE.

There was a reduction in the number of pods plant^{-1}with increased duration of weed infestation at 63 and 84 DAE (Table 2). Conversely, increased duration of weed free recorded a significantly higher number pods plant^{-1}with corresponding increased from 22 to 25 pods plant^{-1} at 0-21 to 0-49 DAE which was comparable to continual weed free duration at 84 DAE.

The fresh fruit weight and fruit yield of okra were significantly influenced by the

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various weed interference durations (Tables 1). Fresh fruit weight of okra recorded higher weight (20 -21 g fruit^{-1}) among the weed free duration except at 0-21 DAE. This was significantly differed from weed infestation duration. Under increasing duration of weed infestation, the fruit yield recorded lowest yield at 0-49 DAE. However, fruit yield did not significantly differ amongst treatments with different durations of weed infestation although there were significant differences with weed interference duration of 49 DAE and unweeded check.

Critical Period of Weed Interference

Weed interference duration in uenced the critical period of weed control (CPWC).The CPWC for increasing length of weed-free period and increasing duration of weed infestation occurred at about 21 and 35 DAE, respectively (Figure 3). The point of intersection of yield against length of weed-free period and increasing duration of weed infestation occurred at 35 DAE. This point used to identify the equalibrium point of control and interference which is the critical period of weed interference. This is consistent with results of Temnotfo and Henry, (2017), who reported that the CPWC in okraoccurred at 36 DAE. According to Dada and Fayinminnu (2010), critical period of weed control in okra was 2-4 WAS because the crop exhibited early sensitivity to weed infestation. Although the findings are consistent with earlier work, Kremati *et al.,* (2008) and Bedmar *et al.,* (1999) have argued that expressing data as days after planting could indicate more variation between locations and years due to different planting dates and different environments. It is suggested that the critical period of weed control should be determined using crop growth stages and environmental variation.

DISCUSSION

Weed species composition

The proliferation of annual grass and broadleaf weeds in this study is evident to highly disturbed environments that favour the succession of weeds. Ibrahim *et al.* (2009) reported that the preponderance of weeds that emerged after disturbance indicated that there was a change in weed flora composition and density. The results also showed that *Hyptissuaveolens* and *Imperata cylindrica* were the most dominant weed species andoccurred throughout the different weed-infested and weed-free interference durations. This might be attributed to the allelopathic potential of these weeds to suppress some other weeds in order to colonize the ecological niche.

Effect of weed interference duration oncrop performance, weed density, biomass and crop yield

The plant height, number of branches and leaves was highest with the increased in the length of the weed free duration and at mid-term control of the weed infested treatments. The length of weed control in okra is critical most especially at the early growth stage of the crop because of reduced weed population densities and subsequently reduced yield losses associated with weed interference. This agrees with Adejonwo *et al.* (1989), who found that allowing weed interference in beyond 3 WAS will have adverse effect on okra plants. This is also consistent with the report of Ayeni and Oyekan (1992) and Dada and Fayinminnu (2007), that most crops have certain range of ability to withstand weed competition and length of period in which they are required to be weed free.

The results further revealed that weed densities and weed dry weight had a direct relationship with the duration of weed interference.Under increased length of the

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weed-free period, there was also tendency for lower weed densities and weed dry weight. Weed population densities at the later time of the weed infested treatments were consistently reduced following removal. Weed populations allowed to grow with the crop at emergence are more aggressive in terms of overall yield reduction than those that establish later in the season. Radosevich and Holt (1984) reported that the higher the weed density and coexistence, the greater the intra and inter-specific competition amongst weeds and crops, which increases plant mortality particularly amongst weeds themselves leading to their lower density. Weed density may therefore not be a onlyfactor to describe the responses of crops yield to weeds but in combination with weed dry weight however, the two indices can be used to identify competitive species that have the ability to better access light, nutrients, and water resources in limited space, thus suppressing the growth and reproduction of nearby weed species Worthington *et al.*(2015).

The yield of okra under increasing length of weed-free conditions showed a higher range for yield from 2.0 to 2.8 tons ha^{-1}while increased duration of weed infestation ranged from 2.0 to 2.8 tons ha^{-1} while that under increasing length of weed-free conditions showed a higher range for yield from 1.8 to 2.7 tons ha^{-1}.Singh *et al.* (1996)reportedsusceptibility of okra to early weed infestation owing to its slow juvenile growth habit.

Critical Period of Weed Interference

The study identified the crossing point of the critical weedfree period and the critical period of weed infestation which is defined as the equality point of control and interference. According to Singh *et al.*(1996),this point determines the equality of increasing or decreasing crop yield in response to competitive conditions.The point of intersection of yield against length of weed-free period and increasing duration of weed infestation occurred at 35 DAE. This is consistent with results of Mncube and Banda, (2017), who reported that the CPWC in okraoccurred at 36 DAE. According to Dada and Fayinminnu (2010), critical period of weed control in okra was 2-4 WAS because the crop exhibited early sensitivity to weed infestation. Although the findings are consistent with earlier work, Krematì *et al.,* (2008) and Bedmar *et al.,* (1999) have argued that expressing data as days after planting could indicate more variation between locations and years due to different planting dates and different environments. It is suggested that the critical period of weed control should be determined using crop growth stages and environmental variation.

The results of this research can be used to assess the relative timing of weed control practices in okra. Knowledge of the critical period of weed control can also allow farmers to use one control operation for maximum benefit in weed management or returns. Information on patterns of weed emergence can also be useful in determining which species are more likely to be controlled by a particular practice either single to coincide with the critical period or species exhibiting multiple emergence cohorts that will likely require several control practices to achieve an acceptable level of suppression.

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Table 1: Common weed species identified in the study area

Family name	Scientific name	Common name	Life cycle
Grasses			
Poaceae	*Cynodon dactylon* (L.) Pers	Bermuda grass	P
	Digitariahorizontalis (wild)	Digitaria	P
	Eleusine indica (L.) Gaertn	Goose grass	A
	*Eragrostistremula*Hochst	Love grass	A
	Imparata cylindrica (L.) Raeuschel)	Speargrass	P
	Paspalumconjugatum Berg.	Buffalo grass	A
Sedges			
Cyperaceae	*Cyperus esculentus* (L.)	Yellow nutsedge	P
	Cyperus difformis (L.)	Small umbrella	P
	*Kyllingaerecta*Schum		P
Broadleaves			
Lamiaceae	*Hyptissuaveolens*poit	Pignut	A
Euphorbiaceae	*Euphorbia hirta*(L.)	Asthma-plant	A
	Euphorbia heterophylla(L.)	Milkweed	A
Loganiaceae	*Spigeliaanthelmia* L.	Worm grass	A
Amarantaceae	*Amaranthushybridus* (L.)	Common pigweed	A
Convolvulaceae	*Ipomeapurpurea* (L.) Roth	Morning glory	P
Asteraceae	*Acanthospermumhispidum* (DC.)	Bristly starbur	A
	Bidenspilosa (L.)	Blackjack	A
	Tridaxprocumbens(L.)		A
	Ageratum conyzoides L.	Billy goat weed	A
Commelinaceae	*Commelinabenghalensis*	Wandering Jew	P

Life cycle - A, annual and P, perennial

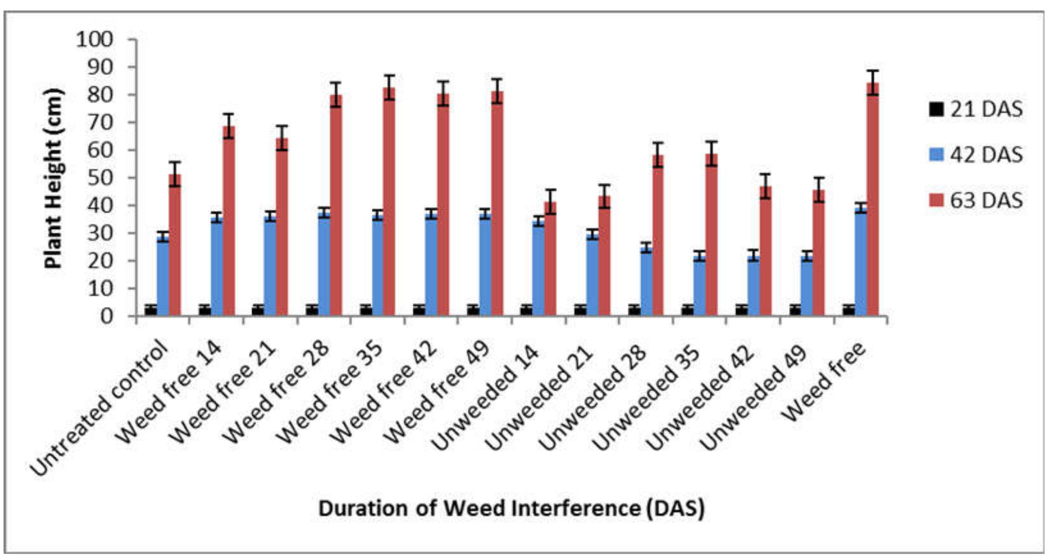

Figure 1: Effect of weed interference duration on plant height

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Table 2: Effect of weed interference duration on number of branches and leaves plant-1

Treatment	Number of branches plant^{-1}			Number of leaves plant^{-1}		
	21	42	63	21	42	63
		DAE			DAE	
Untreated control	2.7	2.7	3.2	4.7	5.3	5.7
Weed free 0-14 DAE	3.6	4.9	4.3	5.0	6.3	7.3
Weed free 0-21 DAE	3.7	5.3	5.7	4.7	9.3	9.3
Weed free 0-28 DAE	3.3	5.6	5.3	4.3	9.3	10.3
Weed free 0-35 DAE	3.3	5.7	5.3	4.5	10.3	10.3
Weed free 0-42 DAE	3.5	5.4	5.7	4.8	9.7	10.7
Weed free 0-49 DAE	3.4	3.4	5.7	4.5	10.0	10.0
Unweeded 14 DAE	2.7	3.3	3.3	4.7	6.3	7.7
Unweeded 21 DAE	2.3	3.3	3.7	4.4	8.3	8.3
Unweeded 28 DAE	3.2	3.3	3.3	4.9	8.7	9.0
Unweeded 35 DAE	3.2	3.3	3.7	4.6	7.0	7.9
Unweeded 42 DAE	3.3	3.3	3.7	4.7	6.33	7.67
Unweeded 49 DAE	2.9	3.5	3.7	4.7	6.33	7.3
Weed free	3.7	5.33	6.0	4.5	10.67	11.57
s.e.d.	0.42	0.45	0.4851	0.30	0.53	0.50
l.s.d.	0.85	0.91	0.99	0.61	1.08	1.01
cv%	1.1	1.4	2.3	1.2	1.3	2.0
F-pr	0.064	<.001	<.001	0.071	<.001	<.001

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Table 3: Effect of weed interference duration onweed density, weed dry weight and fruit yield

Treatment	Weed Density No/m^2	Weed Dry weight (g)	Number of pods plant^{-1} DAS 42	84	Fresh weight pod^{-1} (g)	Fruit yield t/ha
Untreated control	47.0	208.7	9.7	10.7	13.3	1.4
Weed free 0-14 DAE	13.7	67	10.7	12.3	17.3	2.0
Weed free 0-21 DAE	11.0	63.7	12.0	22.3	18.3	2.4
Weed free 0-28 DAE	12.7	64.3	13.0	23.3	20.7	2.4
Weed free 0-35 DAE	12.7	59.3	13.3	24.7	20.0	2.6
Weed free 0-42 DAE	13.0	58.7	13.4	24.0	20.7	2.7
Weed free 0-49 DAE	21.7	96.7	15.7	23.7	20.7	2.8
Unweeded 14 DAE	37.0	157.3	8.7	14.0	14.7	2.7
Unweeded 21 DAE	26.3	87.7	11.3	16.7	16.0	2.7
Unweeded 28 DAE	29.3	74.3	10.7	13.7	18.3	2.6
Unweeded 35 DAE	25.7	60.7	10.7	13.7	15.0	2.7
Unweeded 42 DAE	21.3	61.7	10.7	12.3	16.7	2.2
Unweeded 49 DAE	20.0	48.3	7.7	12.0	15.33	1.8
Weed free	0.0	0.0	16.7	25.3	21.0	3.0
s.e.d.	4.74	19.97	1.36	1	1.01	0.13
l.s.d.	9.68	40.78	2.78	2.05	2.24	0.27
cv%	6.4	6.6	1.8	2.9	1.1	1.9
F-pr	<.001	<.001	<.001	<.001	<.001	<.001

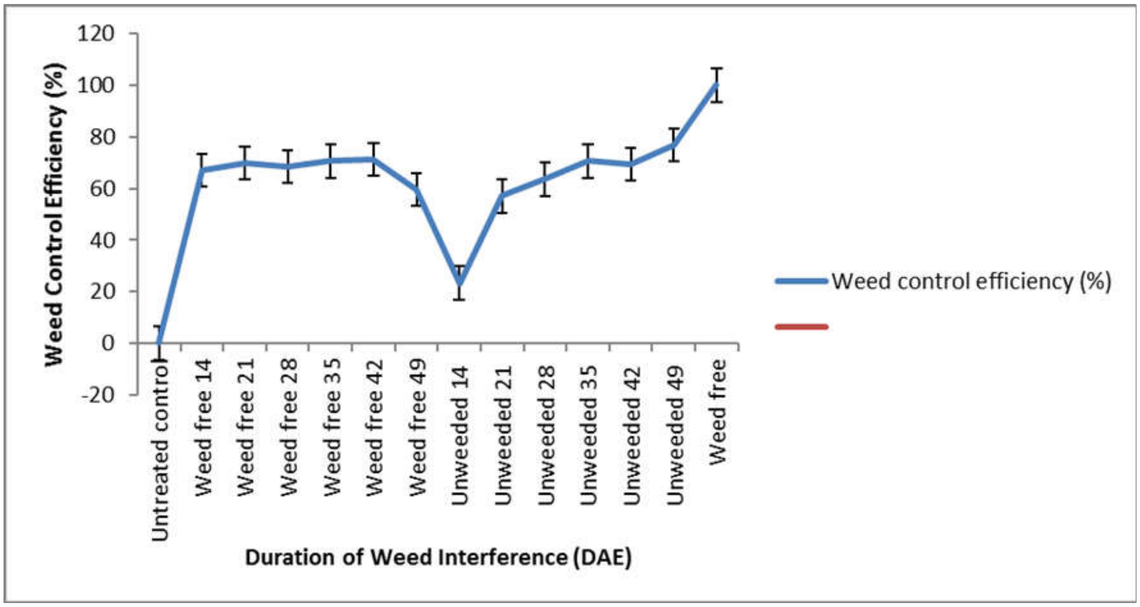

Figure 2: Effect of weed interference duration on weed control Weed control efficiency

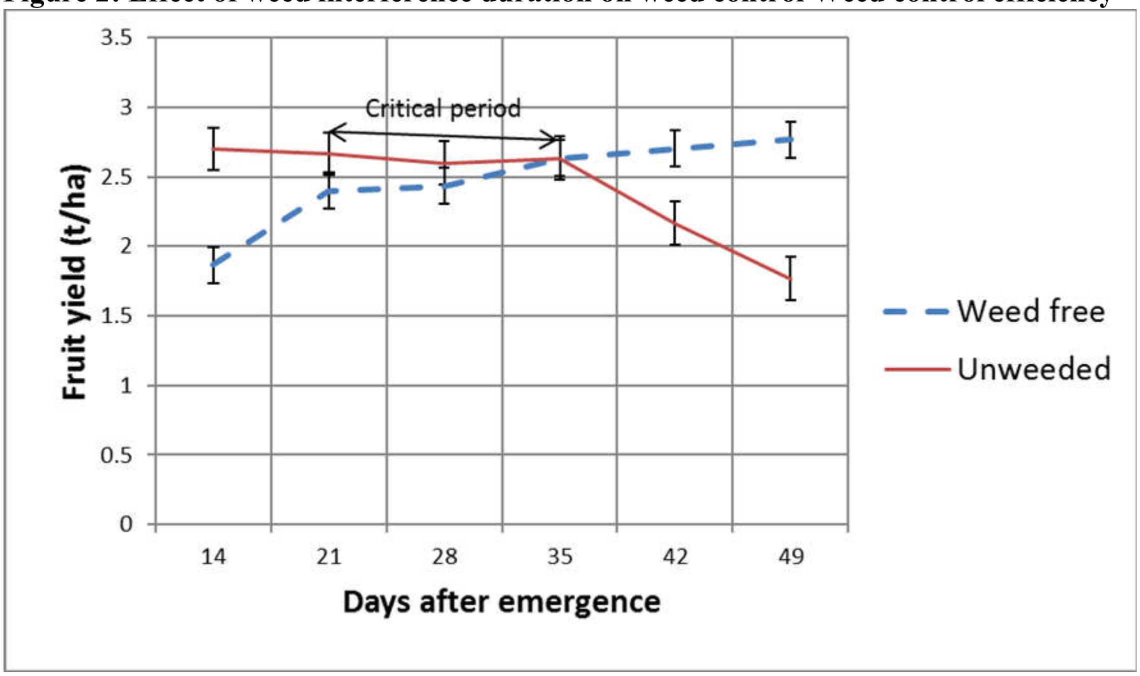

Figure 2: Effect of time of weed interference/removal on fruit yield and magnitude of the critical period.

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Performance of Weed Management Practices on Weed Supression, Growth and Yield of Irrigated Ginger (*Zingiber officinale*roscoe) at Afaka

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ABSTRACT

The objective of this study was to determine the performance of weed management practices on weed suppression, growth and yield of ginger.The field experiment was conducted during the dry season of 2016/2017 at the Olericulture garden of the Federal College of Forestry Mechanization, Afaka, Kaduna ($10^0 21^{1'}$N and $07^0 45^{1'}$E altitude of 644m). The treatment consisted of four mulch materials (sawdust, dried shredded grass, dried shredded leaves and polyethylene film) and four weeding regime at (4,8,12) week after planting (WAP), weed free plot and un-weeded control.the treatments were laid in Randomized Complete Block Design (RCBD) replicated three times. The result obtained indicated that prominent weed species at medium level of infestation were Amaranthus spinosus,Arachis racemosa and Leptochloa coerulescens. Mulching with dried grasses and saw dust gave effective weed control and had higher weed control efficiency and weed control index, thereby suppressed weed growth. This resulted in better growth performance of ginger with taller plant, improved crop vigour and higher yield of ginger rhizome per plant compared with the unweeded treatments. The unweeded controlrecorded reduction in ginger rhizome (35.1%) compared with the yield obtained with dried grass mulched (64.9%). Therefore, mulching with shredded dried grasses could be recommended for effective weed suppression and improved growth and higher ginger rhizome yield in the Northern Guinea savannah Zones of Nigeria.

Keywords: Ginger, mulching materials, weed suppression, weed control efficiency, weed control index.

INTRODUCTION

Ginger (*Zingiber officinale* Roscoe) known with two prominent species called 'Taffin giwa' and 'Yatsum biri', the former being prominent and worldly acceptable specie. It is said to be native of Asia cultivated in India, China, Japan Indonesia Australia, Nigeria and West India. It is grown and widely distributed throughout the tropics. India is the largest producer of 0.7mmt (million metric tonnes) (34.6%), while Nigeria rank 4th as world producer of ginger with production figure of 0.16mmt (7.9%) in 2011. Others are China, 2rd with 0.38mmt (19.1%); Nepal 3rd with 0.21mmt (10.68%) and Thailand being 5th with 0.15mmt (7.8%) (Anonymous, 2018). Ginger has been used for its health benefits for over 5,000years and it is used in Asian medicine to treat stomach aches, nausea and diarrhea. Many digestive and nausea, and cold and flu dietary supplements in the U. S. contain ginger extract. Ginger has been used for

rheumatoid, arthritis, osteoarthritis and joint and muscle pain (Anonymous, 2006). Ginger is slow germinating thereby often affected by weed competition initially, which is identified as a constraint to roots and tuber formation. Akobundu, (1987) reported that weed resulted in 65% reduction in yield of root and tuber crop and 25% total labour force in production, is used in control of weeds. Weed remained one of the most significant agronomic problems, especially on organic farms, because weed control can only be carried out without herbicides (Jodaugiene *et al*., 2006). Mulching as a weed control method is used in agriculture throughout the world (Gupta, 1991), it is known to suppress weeds, reduce tillage for weed control. Mulching is considered important in ginger growth, enhance seedling

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emergence and also provide much required organic nutrient for growth (Olorukooba, 1988). The commonly used mulching materials are polythene, straw wood shavings, dry shredded grasses and leaves.

Weed competition in crop is considered important because it reduces yield as much as 100% thereby competing for nutrient, space light and water (Adigun and Lagoke, 2003). Ginger is not an exception as yield losses of 100% was recorded in Ethiopia due to uncontrolled weed growth (Eshetu and Addisu, 2015).

Presently there is dearth of information on organic weed control measures in ginger despite its phytochemical constituents, and beneficial importance to health;Mulching has the advantage of suppressing weed, avoiding damage to the crop ginger and improving the soil nutrient and moisture. However, mulch materials vary and research work is limited on the performance and recommendation on the growth of ginger. Weeding commonly carried out by peasant farmers, could be laborious and expensive leading to greater yield loss (Adigun and Lagoke, 2003).Cultural control practices of application of mulch materials and weeding regime could be one of the ways to alleviate weed challenges, experienced in ginger production. In order to improve the growth and yield research work carried out on mulching and chemical weed control in ginger Olorukooba (1988) as most chemicals recommended are obsolete and not readily available and quite expensive, in effect application of mulch will not only suppress weed but will also help reduce soil moisture loss in the ginger producing areas of Kaduna State, being the largest in Nigeria.

This work was therefore conceived to determine performance of mulch materials and weeding regimes on weed suppression, growth and yield of the crop ginger.

MATERIALS AND METHODS

Experimental Site

The field trial was conducted at Federal College of Forestry Mechanization, Afaka, Olericulture site located at 644 above sea level at latitude 10^0 N 35^1 and longitude 07^0 E 21^1 in the Northern Guinea Savanna agro-ecological zone. Experimental treatment consisted of four (4) treatments including mulching materials (shredded dry grasses, shredded dry leaves, saw dust, polythene film) and five (5) weeding regimes at 4, 8,12 (WAP) weed free and unweeded control.

Cultural Practices

The selected site was cleared of weeds and debris, soil was loosened to avoid clods, ridges done manually at spacing of 25cm x 25cm. Seed was traditionally Tafin giwa (yellow) at the rate of 1.5 t/ha. The pre-germinated seed was cut into sett size of 10gm applied and treated with Apron plus at the rate of 10g/1kg seeds. Mulching materials were from the college premises as dry shredded grasses of *Pennisetum purpureum*, *Isoberlina doka* as dry shredded leaves, saw dust as shaving from wood technology workshop. Planting was carried out by digging 5cm of hole at a spacing of 25 cm x 15cm. Mulching was done with materials based on treatment specification per plots at 2kg weight and uniformly spread to 5 cm thickness at least thrice, immediately after planting and subsequently when the need arises. Polythene film with sheet cut into size and hole was made based on plant spacing.

Weeding regime was done by hand pulling manually according to specification at 4 week intervals.

RESULTS

The weed composition and their level of infestation are shown on (Table1). According to the observation made during the experiments three classes of weed were observed broad leaves, sedges and grasses. However, grasses family recorded the

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highest number and the level of infestation whereas the sedges had the minimum number followed by broad leaves. Examples of weed identified were *Amaranthus spinosus*, *Arachis racemosa*, *Leptochloa coerulescens* at medium level of infestation.

Table 2 contained weed control index (WCI) and weed control efficiency (WCE) obtained on mulching and weeding regime. At 4, 8, 12 and 16 WAP sampling period, WCI and WCE increased significantly with treatments on mulched plots compared to unweeded plot and weeding regime at 4, 8, 12 WAP respectively. During the investigation period at 8 and 16 WAP, crop vigour (Table 3) indicated better growth performance with a significant effect of weed management practices of mulching and weeding regime on all the treatment compared to the unweeded control. Number of leaves produced throughout the investigation period did not differ significantly by mulching and weeding regime.

Taller plants were produced and only significant at 12WAP. Mulching with shredded dried leaves produced significantly taller plant than mulching with polythene sheet. All other treatments had comparable taller plants. At harvest, both number of ginger rhizome and weight of ginger rhizome produced were significant. Application of shredded dried grasses gave increased number of ginger rhizome resulting in higher ginger weight and was comparable to mulching with saw dust.

DISCUSSION

Weed infestation are common on crop field when factors of productions (light, water, space, and nutrient)are limiting as experienced in this trial resulting in competitive ability. Common weed samples observed during the trial were mostly grasses, sedges and broad leaves. Highly infested weed sample on ginger rhizome are,*Arachis racemosa*, L*eptochloa coerulescens Steudcynoden dactylen* at low level of infestation. The morphological structure of these weeds are quite similar as monocotyledons crops, which might cause differential effect on ginger growth. This is accordance with DAS, (2011) who observed that weeds have similar morphological characteristic, growth and appearance as that of some crops particularly at early stage there by limiting its competitive ability. Mulching suppressed weed resulting in higher weed control efficiency and weed control index as obtained in this trial. Mulching with shredded dried grasses and with sawdust exhibited better weed suppression that was comparable with weed free plot. The result is similar to report that mulch materials has the ability to smoother weeds thereby controlling weed problem as suggested by Olabode*et al*., (2007) compared with weeding regime whose weeds could exhibit initial weed competition for nutrient, water, sunlight and space before it was removed. Weed suppression allowed better growth performance of plot treated with mulch materials than weeding regime, similar observation with weed suppression in mulched plots. The result also conforms with Ihenacho *et al*., (2014) who worked on mulch material on turmeric. The improved growth performance of mulch plot probably was due to availability of space for the growth of the crop that could be growing toward sunlight as monocotyledons. More so, weed that could compete with crop had been suppression. The number of leaves though not significant were also available in abundance, thereby increasing the photosynthetic rate of plant.

In this study, ability of mulch treatment of shredded dried grasses to suppress weed, improved growth parameters (crop vigor, plant height) of ginger plants, resulting in

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significant rhizome yield. It was observed that 64.9% increased yield of rhizome ginger was obtained with mulching with shredded dried grasses that gave effective weed control than the least obtained with unweeded plot 35.1%. The result is in accordance with Shechambo *et al*., (2015), whereby higher tomato yields were recorded in wet and cold season in Mexico in mulched plants.

CONCLUSION AND RECOMMENDATION

Therefore, for effective weed suppression, growth and higher rhizome ginger yield, application of 2kg of shredded dried grasses could be recommended in the Northern Guinea Savannah Ecological Zones.

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Table 1: Weed Samples observed and level of infestation during the study at the farm.

Types of Weed	Level of Infestation
Broad Leaves	
Amaranthus spinosus	+
Boerhavia diffussa	+
Melitous indica	+
Commelina benghalensis	+
Cynodon dactylon	++
Sedges	
Ludwigia abyssinica	+
Cyperus amabilus	+
Pysalis minia	+
Grasses	
Eleusine indica	+
Arachis racemose	++
Leptochloa coerulescens	++
Dactyloctemum acgyptum	+

Key: + Leastinfestation, ++ Medium infestation +++ High infestation

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Table 2: Performance of Weed Management practices on Weed Control Index and Weed Control Efficiency of Irrigated Ginger during the dry season 2017 at Afaka

	Weed Control Index (%) At				**Weed Control Effi**	
Treatments	**4**	**8**	**12**	**16 (WAP)[1]**	**4**	**8**
Mulching with Shredded dried grasses	41.19bc	79.17a	79.17a	86.07a	25.57ab	21.72
Mulching with Shredded Dried Leaves	51.12ab	74.99a	74.99a	82.28a	13.200bc	16.30
Mulching with Sawdust	52.67ab	70.99a	70.99a	75.90a	20.29abc	21.76
Mulching with Polythene	29.12bc	65.30ab	65.34a	70.45a	22.68ab	22.68
Weeding at 4 WAP	27.78bc	69.39a	69.39a	62.30a	24.39ab	30.20
Weeding at 4, 8 WAP	44.58b	43.02b	58.55a	52.08a	16.96bc	26.46
Weeding at 4, 8, 12 WAP	40.11bc	32.23bc	31.14b	40.40b	22.92ab	20.47
Weed Free Plot	89.14a	84.31a	84.31a	89.52a	40.62a	34.28
Unwedded plot (control)	0.00c	0.00c	0.00c	0.00c	0.00c	0.00b
SE±	7.31	4.68	4.79	3.52	3.89	3.72

[1]Weeks after Planting (WAP), [2]mean within the same row are not significantly different at p 0.05 using Duncan Multiple Range Test

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Table 3: Performance of Growth and Yield of Irrigated Ginger as affected by Weed Management Practices during the 2017 dry season at Afaka

	Crop Vigour		Plant Height			No. of Leaves			No. of Rhizome/plant	Weight of Rhizome (g) plant
Treatments	**8**	**16**	**8**	**12**	**16 (WAP)[1]**	**8**	**12**	**16 (WAP)**	**At Harvest**	
Mulching with Shredded dried grasses	4.33a	6.67ab	10.67a	21.77ab	27.60a	3.33a	5.00a	6.00a	5.00a	98.07a
Mulching with Shredded Dried Leaves	3.33a	7.67a	10.00a	24.00a	27.87a	5.00a	6.67a	8.00a	3.33bc	89.81ab
Mulching with Sawdust	2.33	7.33ab	10.73a	12.90ab	24.90a	4.00a	6.33a	8.33a	4.33ab	99.08a
Mulching with Polythene	3.00	6.67ab	8.00a	9.10b	16.33a	3.33a	5.67a	7.33a	3.33c	61.76d
Weeding at 4 WAP	3.33	6.67ab	10.67a	15.90ab	19.87a	2.67a	5.00a	6.00a	2.33c	36.11g
Weeding at 4, 8 WAP	4.67	7.67a	14.00a	18.90ab	19.23a	4.67a	7.00a	9.00a	3.00c	54.15c
Weeding at 4, 8, 12 WAP	3.00	8.67a	8.00a	19.50ab	21.83a	4.00a	6.67a	6.67a	2.67c	37.72f
Weed Free Plot	3.00	8.67a	11.67a	21.60ab	26.90a	4.00a	5.67a	6.67a	4.33ab	77.11c
Unwedded plot (control)	3.00	5.33b	12.67a	13.0ab	20.00a	5.33a	7.33a	8.33a	2.33c	34.43g
SE±	0.50	0.37	2.26	2.55	1.99	0.91	0.96	0.72	0.21	0.55

[1] Weeks after Planting (WAP), [2]mean within the same row are not significantly different at p 0.05 using Duncan Multiple Range Test

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Effect of Weeding and Insecticidal Application on Fungal Load of Harvested Soybean seeds

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Abstract
A field experiment comprising four weeding regimes and four levels of insecticidal application factorially combined and fitted in a randomized complete block design was carried out to determine their effects on seed mycoflora load of soybean at harvest. The different weeding regimes and insecticide application levels showed no significant consequence on mycoflora load of harvested seeds in treated plants. The different combinations of weeding and insecticide application however had significant effect ($p<0.05$) on the mean number of fungi isolated from the harvested seeds of soybean cultivar TGX 1448-2E. A combination of weeding (at least once) and insecticide application (at least twice) reduced fungal flora of the seeds most significantly ($p<0.05$). Aspergillus niger, Curvularia lunata and Penicillium oxalicum were the most affected fungal isolates. The mean number of Fusarium oxysporum and Phomopsis sp. were not significantly different throughout the experiment.
Keywords: *Weeding, Insecticidal application, Soybean seeds, Fungal load*

INTRODUCTION

Soybeans represent the world's most important oilseed as a source of vegetable oil and protein. In Nigeria, the crop is becoming increasingly important as substitutes for protein from animal sources because it is cheap and affordable. Diseases can significantly affect yield level and quality of the crop. More than 135 microorganisms have been described on soybean, but only about 30 species belong to the group of economically important pathogens (Roy *et al*., 2000). Some of these pathogens are now known to be seed-borne in nature (Shovan *et al*., 2008). Seed-borne pathogens may cause disease or death of the plants resulting in crop and food loss and when stored for direct consumption, seed-borne organisms may cause chemical changes and deterioration or mycotoxin release with potentially harmful effect on humans and livestock (Chiarapa and Gambogi, 1986).

There are reasons to belief that seed infection by fungal pathogens takes place through weeds which serve as alternate host to the pathogens and also through insects that feed on the plant as well as those that pollinate the plant. Studies have shown that less seed infection by *Fusarium semitectum*, *Cercospora kikuchii*, *Phomopsis* spp., and *Rhizoctonia solani* occurred in plots where weeds were controlled compared to weedy plots (Bowman *et al*, 1986; Bradley *et al*, 2001; Chagas & Dhingra, 1979; Dhingra & Da Silva, 1978). Insects are particularly important in facilitating the entry of a pathogen into its host through the wounds they make on aboveground or belowground plant organs and in some cases they help the survival of the pathogen by allowing it to over-season in their body (Agrios, 2005). Dispersal of fungal spores by insects is recognized in many groups of fungi including *ascomycetes*, *basidiomycetes*, imperfect fungi and *zygomycetes* (Kendrick, 1985) as well as in slime moulds (Stephenson and Stempen, 1994). The objective of this study was to determine the effect of weed and insect control in soybean field on the fungal load of harvested seeds.

MATERIAL AND METHODS

Seeds of Soybean Cultivar TGX 1448-2E obtained from Shonga soybean farm in Kwara State was used for this study. The experiment was conducted at the Teaching and Research Farm of the University of Ilorin, located within the Southern Guinea

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Savannah ecological zone (9°29' N, 4°35' E) of Nigeria. The land was ploughed, harrowed twice and then ridged. Four seeds were planted per hole and the seedlings were thinned to two plants per stand after germination. The planting was done in June, 2015.

Treatment design

The following treatment combinations were tested on the field;

W_0I_0	W_1I_0	W_2I_0	W_3I_0
W_0I_1	W_1I_1	W_2I_1	W_3I_1
W_0I_2	W_1I_2	W_2I_2	W_3I_2
W_0I_3	W_1I_3	W_2I_3	W_3I_3

W_0I_0 (No weeding, No insecticide application); **W_0I_1** (No weeding, Insecticide application once); **W_0I_2** (No weeding, Insecticide application twice); **W_0I_3** (No weeding, Insecticide application thrice); **W_1I_0** (Weeding once, No insecticide application); **W_1I_1** (Weeding once, Insecticide application once); **W_1I_2** (Weeding once, Insecticide application twice); **W_1I_3** (Weeding once, Insecticide application thrice); **W_2I_0** (Weeding twice, No insecticide application); **W_2I_1** (Weeding twice, Insecticide application once); **W_2I_2** (Weeding twice, Insecticide application twice); **W_2I_3** (Weeding twice, Insecticide application thrice); **W_3I_0** (Weeding thrice, No insecticide application); **W_3I_1** (Weeding thrice, Insecticide application once);**W_3I_2** (Weeding thrice, Insecticide application twice)L **W_3I_3** (Weeding thrice, Insecticide application thrice)

The first weeding was effected by application of pre-emergence herbicide. Subsequent weed control measures involved manual removal of weeds either once, or twice after initial herbicide application during the active growing period of the plants.

Experimental Design

The experiment was a factorial fitted into a Randomized Complete Block Design. The land area used was 225m^2 with 0.5m alleyways within plots and 1m between the blocks. Each treatment combination was replicated thrice and each treatment replicate was randomly assigned to the plots.

Agronomic Practices

Glyphosate (the pre-emergence herbicide) was applied at the rate of 3litres/ha. Manual weeding by hoeing was repeated once and twice thereafter as appropriate. Control of insects was achieved with the use of Cypermethrine (2.5EC) applied at the rate of 500ml/500litre. Herbicide and insecticide applications were carried out using Knapsack sprayer. Insecticide was applied at seedling stage, just before flowering and at flowering/podding stages.

Harvesting

Harvesting was done by handpicking the mature pods from the plants. Harvested pods were packaged separately according to treatment combinations in labeled polyethylene bags and were moved to the laboratory for further processing and seed health testing.

Seed Health Testing and Incidence of the isolated fungi

This was carried out using the agar plate method as described in the International Seed Testing Association (ISTA, 1996) procedure. The seeds were pre-treated with 0.5% sodium hypochlorite for 30 seconds followed by rinsing in several changes of sterile water. The seeds were then plated on sterile Potato Dextrose Agar (PDA) medium amended with 1% streptomycin sulphate in petri dishes (9 cm diameter) at the rate of ten seeds per plate. Five replicate plates were used and the plates were incubated for seven days under twelve hours alternating cycles of light and darkness at 22 ^{0}C ± 2 ^{0}C . Incubated seeds were examined for mycelial growth and the fungal colonies were examined.

The incidence of each isolated fungus was determined as follows;

Percentage Incidence = Number of isolated fungus

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Total number of fungi isolated in the cultivar X 100

Identification of isolated fungi

Temporary slides were prepared for each of the isolates**.** The slides were then observed under a compound microscope (Olympus). The morphological and microscopic features were recorded. These features were matched with those described in standard references (Kulwant *et al*., 1994; Malone and Muskett, 1997; Mathur and Kongsdal, 2003) for identification of the isolates. The identities of the isolates were confirmed at the Plant Pathology Laboratory of the International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria.

Data Collection and Analysis

Mean number of fungal isolates recovered from the soybean seeds were recorded for each of the treatment combinations. Analysis of variance was conducted using SPSS Version 21 statistical package. Where significant difference was recorded, the mean values were separated using the Duncan's New Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

The results showed that weeding alone had little or no significant consequence (p 0.05) on seed mycoflora load of treated plants (Figure 1). The same applied to insecticide application as a factor (Figure2). Weeding generally reduced the mean number of *A. niger* and *Phomopsis* sp. but the mean number of *C. lunata, F. oxysporum* and *P. oxalicum* increased with weeding only once. As the number of weeding increased, the mean number of these organisms isolated was reduced.

Insecticide application reduced the mean number of *Penicillium* sp. and *Phomopsis* sp. but the reduction was not significant (p 0.05). There was an initial increase in the mean number of *Aspergillus* sp., and *Curvularia* sp. with increase in the number of time insect control was carried out from once to twice. At the third application, the mean number of the organisms was eventually reduced.

Different combinations of weeding and insecticide application had significant effect ($p<0.05$) on the mean number of *A. niger, C. lunata* and *Penicillium oxalicum* isolated from the seeds but not on the mean number of *Fusarium* sp. and *Phomopsis* sp. (Table 1). The lowest mean number of *A. niger* (0.33) was observed in the treatment combination involving weeding once-no insecticide, twice-insecticide once and thrice-insecticide once. *Curvularia lunata* had the lowest mean number (1.00) in treatment combination involving application of no weeding-insecticide thrice and weeding thrice-insecticide twice. *P. oxalicum* was completely eradicated with weeding thrice and insecticide application twice while *Phomopsis* sp. was completely eradicated with weeding once-insecticide twice, weeding thrice-insecticide thrice and weeding thrice-insecticide once.

There is reason to belief that insects and weeds played important role in the composition of the mix of fungal flora associated with harvested soybean seeds in the field. Seedlings under the combined effect of insecticide application at least twice and weeding at least once in this study showed reduced fungal flora of the harvested seeds. The reason for this observation may be that the control of the insects had prevented fungal spore dispersal and the consequent seed infection.

Dispersal of fungal spores by insects is recognized in many groups of fungi including *ascomycetes*, *basidiomycetes*, imperfect fungi and *zygomycetes* (Kendrick, 1985) as well as in slime moulds (Stephenson and Stempen, 1994). No one particular taxonomic group of insects however, seems to be strongly associated with vectoring of herbaceous plant pathogens.

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Another observation made in this study was that plots without weeding had seeds with significant infection with *A. niger*. No weeding treatment leading to significant increase in *A. niger* incidence on the seeds is an indication of the role of high moisture level inducing mouldy growth. It is to be noted that plots without weeding at all had higher level of weed population which must have significantly influenced the local humidity profile of the plant milieu. There is need for more literature to back up these results.

CONCLUSION AND RECOMMENDATIONS

Weeding and insecticide application as the main factors had no significant effect on the fungal load of the seeds of treated plants but the effect of combination of weeding and insecticide application was significant. Combination of insecticide application at least twice and weeding at least once will help to reduce fungal load of the seeds.

On the field, proper agronomic practices especially control of insect pests and weeds should be encouraged for effective control of seed-borne infection that may be carried from field to store.

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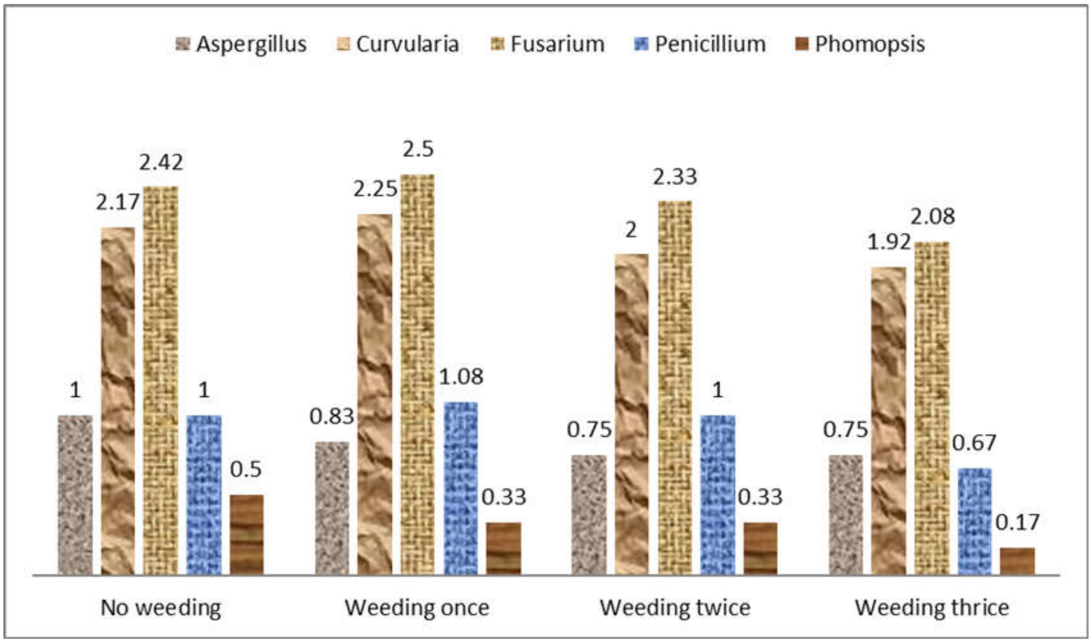

Figure 1: Effect of weeding on mean number of fungi isolated from soybean variety TGX1448-2E

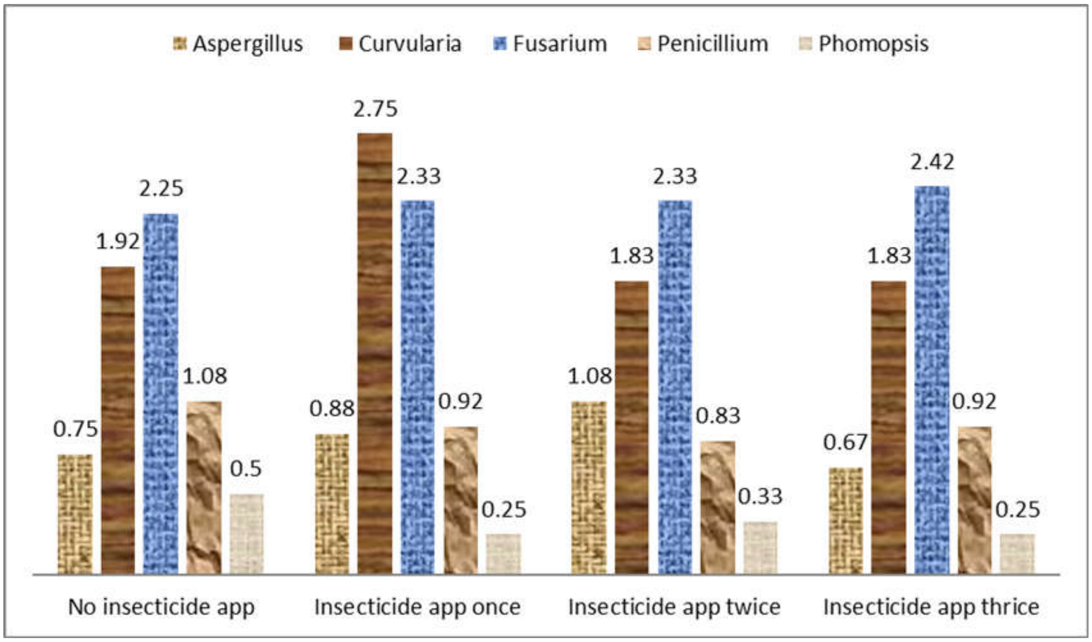

Figure 2: Effect of insecticide control on mean number of fungi isolated from soybean variety TGX1448-2E

Table 1: Effect of treatment combination of weeding and insecticide application on the mean number of fungi isolated from harvested soybean seeds.

Treatments	*A.niger*	*C.lunata*	*F.oxysporum*	*P.oxalicum*	*Phomopsis*
No weeding No insecticide	0.67^{ab}	1.67^{ab}	3.00	1.33^{a}	0.33
No weeding Insecticide once	1.00^{ab}	3.67^{a}	2.00	1.00^{ab}	0.33
No weeding Insecticide twice	1.67^{a}	2.33^{ab}	3.00	1.00^{ab}	0.67
No weeding Insecticide thrice	0.67^{ab}	1.00^{b}	1.67	0.67^{b}	0.67
Weeding once No insecticide	0.33^{b}	2.33^{ab}	1.67	1.00^{ab}	0.67
Weeding once Insecticide once	1.67^{a}	2.33^{ab}	3.00	1.33^{a}	0.33
Weeding once Insecticide twice	0.67^{ab}	2.00^{ab}	1.67	1.00^{ab}	0.00
Weeding once Insecticide thrice	0.67^{ab}	2.33^{ab}	3.67	1.00^{ab}	0.33
Weeding twice No insecticide	1.33^{ab}	1.67^{ab}	2.33	1.00^{ab}	0.67
Weeding twice Insecticide once	0.33^{b}	2.67^{ab}	2.00	0.67^{b}	0.33
Weeding twice Insecticide twice	0.67^{ab}	2.00^{ab}	2.33	1.33^{a}	0.33
Weeding twice Insecticide thrice	0.67^{ab}	1.67^{ab}	2.67	1.00^{ab}	0.00
Weeding thrice No insecticide	0.67^{ab}	2.00^{ab}	2.00	1.00^{ab}	0.33
Weeding thrice Insecticide once	0.33^{b}	2.33^{ab}	2.33	0.67^{b}	0.00
Weeding thrice Insecticide twice	1.33^{ab}	1.00^{b}	2.33	0.00^{b}	0.33
Weeding thrice Insecticide thrice	0.67^{ab}	2.33^{ab}	1.67	1.00^{ab}	1.00
	*	*	NS	*	NS

Values are means of five replicates
Values in the same column followed by the same letter(s) are not significantly different at p=0.05
*Significantly different at p=0.05
NS Not significantly different

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Effect of Variety and Intra row Spacing on the Growth and Yield of Sesame (*Sesamum indicum* L.) in Yola and Dadinkowa

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Abstract

Field trial was conducted during the 2016 rainy season at Teaching and Research Farms, Modibbo Adama University of Technology Yola, Federal College of Horticulture Dadinkowa, Yamaltu Deba Local Government Area Gombe State respectively to determine the effects of variety and intra row spacings on the growth and yield of sesame (Sesamum indicum L.). Three sesame varieties (NCRIBen01M, NCRIBen04E and E8), and three intra row spacing (20, 30 and 40cm) were used. The nine treatments combinations were laid in a Split plot design consisting of 27 plots, where variety was allocated to the main plot and intra row spacing to the sub plot and replicated three times. The results of this research revealed that variation existed in the performance of the varieties on the growth parameters observed during the sampling period. On plant height, E8 had the largest values at 4, 6 and NCRIBen04E was the highest for capsules production at both locations. For number of leaves, no significant difference was recorded between the varieties at 4 weeks after sowing (WAS) for both locations. However, at 6 and 8 WAS significant difference was recorded at Yola where NCRIBen01M had the largest number of leaves, while NCRIBen04E at 8WAS was the largest at Dadinkowa. There was no significant difference recorded between the intra row spacings at 4 WAS at both locations and 8 WAS at Dadinkowa, but significant differences were recorded at 6 WAS for both locations and 8 WAS at Yola. No significant difference was recorded on 1000 seeds weight at Yola, but significant difference existed at Dadinkowa where NCRIBen01M recorded the highest mean value of 3.32g while NCRIBen04E and E8 were statistically at par with 2.25g. Significant difference was recorded at Yola on yield/hectare where NCRIBen04E recorded the highest mean value of 802.49kg, while at Dadinkowa location, no significant difference between the varieties. No significant difference was recorded between the varieties as affected by intra row spacing on 1000 seed weight and yield in kilogram per hectare . NCRIBen04E and 30cm intra row spacing were recommended to the farmers in these locations.

INTRODUCTION

Sesame (*Sesamum indicum*L.) is a flowering_plant in the genus *Sesamum*. It belongs to the family *Pedaliaceae*having bell-shaped flowers and opposite leaves, and is one of the oldest cultivated oilseed crops in the world. The genus consists of about 36 species of which 19 are indigenous to Africa (Weis, 1983; Uzo, 1998). But only three species have been reported to be grown for different purpose in Nigeria namely *Sesamum alatum, S indicum* and *S radiatum* (Dabir, 2000). The crop is known as Beniseed in West Africa (Seegeler, 1989). In Nigeria it is locally called Ridi, Ekuku, and Isasa by Hausa, Yoruba and Ibo people, respectively. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods. Sesame (*Sesamum indicum* L.) has been recognized as

crop with a high economic potential in Nigeria. World production of sesame was estimated at 3.7 million tonnes in the year 2005, of which Asia and Africa produced 2.4 and 1.1 million tonnes respectively. The crop production in most African countries has been increasing steadily due to the crop short duration cycle and the good liquidity in the global market (Anon, 2004).

Majority of sesame Farmers in the Study area persistently use local varieties with variableintra row spacing in growing sesame. This leads to low harvest because of poor performance of the local varieties when compared to the improved varieties

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made available by modern Agriculture.The most important prerequisite for good crop production is the availabilityof good quality seeds of high-yielding varieties (Oyekale *et al*., 2014). Even though, sesame has been under cultivation over a long period of time in many parts of the World, it is of recent that it commercial cultivation is capturing the attention of farmers especially in the North-eastern part of Nigeria. This brings about the need for continuous research on the crop so as to find out the variety that suit most the climatic and soil condition of the area (Northern Guinea savannah), and the most convenient and economical spacing for recommendation to farmers in the study area. Therefore research was conducted to evaluate the performance of three important varieties of sesame grown in the Guinea Savannah of Northern Nigeria and also to determine the effect of different intra row spacing on the performance of sesameto evaluate the interaction between variety and spacingon the performance of sesame.

MATERIALS AND METHOD

The research was conducted during the 2016 rainy crop seasons at two locations. The Teaching and Research farms of Federal College of Horticulture Dadinkowa (11°30′, and 10°20′ Yamaltu Deba Local Government Area Gombe State, and Modibbo Adama University of Technology Yola (Latitude 9° 14′ North, and Longitude 11° 14′ East Adamawa State Nigeria.The treatments consisted of 3 sesame varieties (NCRIBen001M, NCRIBen004E and E8), and three Intra row spacing (20cm, 30cm and 40cm). The treatments were arranged in a split plot design where varieties serve as the main plot, while intra row spacings occupy the sub plots in three replications. The gross plot size was 3m×3m (9m^2) with 0.5m space between the plots and 1.0m between replications. All data collected were subjected to analysis of variance (ANOVA) using statistical analysis system (SAS). Least significant difference (LSD) was used to compare the meansat 5% level of significance.

Assessment of Growth, Yield and Yield Related Parameters

Plant height (cm)

Plant height was taken from the 5 randomly selected plants per plot using a standard meter rule, from the base of the plant to the terminal bud of the main stem. This was done at two weeks interval starting from 4 to 10 weeks after sowing (WAS) and the average was recorded.

Number of Leaves

Number of Leaves was taken by counting the leaves produced by the sample plants at 4WAS, 6WAS and 8WAS, the average was recorded.

Number of capsules per plant

Number of Capsules (NC) were counted from the 5 randomly selected plants on each plot at four days interval between 8WAS and 10WASas NC1= first 4 days, NC2= 8 days, NC3= 12 days, NC4= 16 days, NC5= 20 days and the means were recorded.

1000 seed weight (g)

One thousand seeds were randomly taken from the seed lot of each plot and weighed using an electric weighing balance in the laboratory and the values obtained were recorded.

Seed yield (Kg/ha)

Threshed and winnowed seeds were weighed for each plot and this was done for all the treatments. The mean yield for each treatment was then extrapolated to yield per hectare using the following formula;

$$\text{Seeds yield (kg/ha)} = \frac{\text{Grain yield kg/plot}}{\text{Plot size(m}^2\text{)}} \times 10000$$

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RESULTS

Effects of Variety and Intra Row Spacings on the height of Sesame in Yola and Dadinkowa in 2016 wet season

Table 1 showsthe effects of variety and intra row spacings on the height of Sesame in Yola and Dadinkowa in 2016 wet season.There was significant difference between the varieties on plant height throughout the sampling period and at all locations. E8 was significantly taller compared to NCRIBENN01M and NCRIBEN04E that were statistically of the same height at 4 WAS in Yola. At 6 WAS in Yola, and at 4, 6 and 8 WAS at Dadinkowa, NCRIBEN04Eproduces significantly taller plants compared to other varieties tested though it was par with those of E-8 at 6 WAS in Yola.. At 8WAS in Yola and 6 and 8WAS inDadinkowa, E-8 produced the tallest plants compared to other varieties while, at 10 WAS in both locations variety NCRIBEN01M produced the tallest sesame plants. At 6 WAS in Dadinkowa, there was no significant difference the height of sesame varieties tested.The inter change in the performance of the varieties may be due to genetic makeup of the varieties used and the environmental conditions.For intra row spacings, 20cm had the highest values at both locations except at 10WAS at Dadinkowa. 40cm had the lowest mean values at 4, 6 and 8WAS at Yola while 30cm was the lowest at4, 6 and 8WAS. 30cm was the lowest at Yola while 40cm was the lowest at Dadinkowa. This result agreed with Fagam *et al.,* (2016) in Idokor 2018 who reported that increasing the intra-row of sesame positively affects the growth and yield of sesame.

Effects of Variety and Intra Row Spacings on Number of Leaves of Sesame in Yola and Dadin kowa in 2016 wet season

The result in Table 2 showed that therewas no significant difference between the three varieties in Yola location at 4WAS and 4 and 6WAS at Dadinkowa. Significant differences occurred at 6 and 8WAS at Yola and 8WAS at Dadinkowa with NCRIBen01M had the highest mean values at Yola while NCRIBen04E having the lowest values while the same variety had the highest mean value at 10WAS at Dadinkowa while NCRIBen01M had the lowest. With regard tointra row spacing, there was no significant difference at 4WAS for both locations, and 8WAS at Dadinkowa. However, significant difference existed at 6 and 8WAS where 20cm intra row spacing had the highest value of 17.79, while 30cm intra row spacingrecorded the highest value of 33.74 at 8WAS at Yola location. 40cm was the highest at 6WAS in Dadinkowa. The mixed up in the level of significance shown by the result of this research was not in conformity with Mahammed and Hamidu (2018) result who, in a research involving three varieties of sesame reported that number of leaves of sesame was significantly influenced by Inter-row spacing. The significant difference between the three varieties in almost all the growth stages in terms of number of leaves may be attributed to the fast growth of sesame plants between emergences to 10WAS. The interaction of spacing and variety on the number of leaves per plant was not significant in both seasons.

Effects of Variety and Intra Row Spacing on Number of Capsules of Sesame in Yola and Dadinkowa.

The result in Table 3 showed a highly significant difference between the varieties at both locations throughout the sampling period with NCRIBen04E recording the highest mean values while NCRIBen01M averagely had the lowest mean values and this might be due to genetic makeup of the variety. For intra row spacing, significant differences were recorded at both locationswith 30cm intra row spacingson the average having the highest values at NC1, NC2 and NC5 with 5.99, 6.46 and 58.56 respectively. 20cm intra row spacing had the highest values at NC3 and NC4 with 11.64 and 28.73 respectively. 40cm intra row spacingrecorded the lowest value of 4.33 at NC1 and 9.57 at 9.57. This result conform with the findings of Geremew *et al* (2012) who reported that Capsule length of sesame was smaller and number of seeds per capsule was lower at narrow spacing. Number of capsules per plant and number of seeds per capsule is directly related to number of flowers but climatic conditions can affect the percentage of fertilized flowers. Plant population also directly influences the number of capsules per plant, high population or close spacing in the row tends to reduce both the number of capsules and number of seeds per capsule. This showed that apart from genetic makeup, plant population as well as climatic condition affects the performance of Sesame. Roy *et.al* (2009) also reported that in sesame, narrow row sjjpacing (15 cm) gave the lower number of capsules per plant (39.27) while maximum number of capsules per plant (76.89) was recorded in the highest spacing (45 cm). (Kokilavani *et al*., 2007) who reported that"total number of capsules per plant, which is one of the most important parameter for yield of sesame crop was found to be significantly influenced by varieties".

Effects Variety and Intra Row Spacings on 1000 Seeds Weight (G) and Cumulative Plot Yield (Kg) in Yola and Dadinkowa in 2016 wet season

The result in Table 4 showed that there was no significant difference between the three varieties with regard to 1000 seeds weight at Yola location, but significant difference exist at Dadinkowa where NCRIBen01M recorded the highest mean value of 3.32g while NCRIBen04E and E8 were statistically at par with 2.25g. For yield per hectare, NCRIBen04E and E8 were at par with highest values of 802.49kg/ha and 703.72kg/ha while NCRIBen01M had 666.89kg/ha at Yola location. There was no significant difference between the varieties at Dadinkowa but NCRIBen01M had the largest value of 839.50kg/ha while E8 recorded the lowest value of 703.71kg/ha. The intra row spacings result showed that there was no significant difference with regard 1000 seeds weight, but for yield per hectare, 40cm recorded the highest value at Yola location with 765.44kg/ha, while at Dadinkowa it was 30cm intra row spacing that had the highest value with 839.51kg/ha while 20cm recorded the lowest mean values at both locations. The result of this research contradicts the findings of Idokor (2018) who reported that 1000-seed weight was highly significantly affected by spacing, showing wider spacing producing heavier seed weight while the minimum seed weight was recorded by narrow spacing. Similar findings was reported by Olowe and Busari (2003) that1000-seed weight was higher at wider row spacings compared to narrow row spacing, this could be due to higher plant population which reduces the seed size. Furthermore, the insignificant difference recorded in this research on seed yield may be due to other factors as stated by (Siva Prasad *et al*. 2013) that as with other field crops, seed yield of sesame are strongly associated with numerous interrelated characters andthe environmental fluctuation whose knowledge is important for use in sesame yield improvement.

CONCLUSION

From the result of this research, it can be concluded that even though there significant difference between the varieties on plant height, the record of largest value keeps on changing from one variety to another. However, 20cm intra row spacing recorded the highest mean values on plant

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height. NCRIBen04E had the highest number of capsules but there was no intra row spacing with outstanding performance.No significant difference between the varieties at Yola, but there wsa significant difference at Dadinkowa where NCRIBen01M had the largest value. Seed yield/hectare showed significant difference at Yola where NCRIBen04E recorded the highest value. No significant difference on 1000 seed weight and yield per hectare at both locations with regard to spacings. More research should be conducted on these and other varieties to confirm this result and establish fact.

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Table 1: Effects of Variety and Intra-Row Spacings on Plant Height of Sesame in Yola and Dadin Kowa in 2016 wet season

	Yola				Dadinkowa			
Treatments	4WAS	6WAS	8WAS	10WAS	4WAS	6WAS	8WAS	10WAS
Varieties (V)								
NCRIBEN01M	7.68^{b}	23.97^{b}	79.12^{c}	165.43^{a}	8.41^{c}	32.54^{a}	83.96^{b}	153.63^{a}
NCRIBEN04E	7.86^{b}	25.48^{a}	28.24^{b}	136.03^{b}	12.27^{a}	35.17^{a}	92.00^{a}	148.97^{b}
E8	8.46^{a}	25.62^{a}	87.26^{a}	131.04^{c}	9.61^{b}	36.00^{a}	90.00^{a}	147.31^{b}
P>F	**	**	**	**	**	**	*	**
LSD	0.3596	0.5557	0.7106	0.7232	0.8876	3.6733	2.9153	3.0264
Intra row spacings (S)								
20cm	8.89^{a}	28.22^{a}	91.42^{a}	146.53^{a}	11.08^{a}	38.53^{a}	97.78^{a}	150.64^{a}
30cm	7.67^{b}	25.28^{b}	84.07^{b}	140.19^{c}	8.41^{b}	30.17^{b}	79.62^{c}	153.23^{a}
40cm	7.44^{b}	21.56^{c}	77.14^{c}	145.78^{b}	10.80^{a}	35.00^{b}	89.13^{b}	146.03^{b}
P>F	**	**	**	**	**	**	**	**
LSD	0.3596	0.5557	0.7106	0.7232	0.8876	3.6733	2.9151	3.0264
Interaction								
VXS	**	**	**	**	*	*	**	**

*= significant. **= highly significant. WAS= weeks after sowing .Values followed by the same alphabets are statistically not significant.

Table 2: Effects of Variety and Intra-Row Spacings on Number of Leaves of Sesame in Yola and Dadin Kowa in 2016 wet season

	Yola			Dadin	kowa	
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
Varieties (V)						
NCRIBEN01M	8.87ᵃ	18.04ᵃ	34.74ᵃ	10.22ᵃ	21.33ᵃ	34.53 ᵇ
NCRIBEN04E	9.06ᵃ	17.27ᵇ	32.00ᵇ	10.28ᵃ	22.22 ᵃ	38.06 ᵃ
E8	9.14a	17.52ᵇ	32.31ᵇ	10.35ᵃ	21.33 ᵃ	35.86ᵇ
P>F	NS	**	**	NS	NS	*
LSD	0.4715	0.3926	0.3484	0.5456	1.4921	2.7008
Intra row spacings(S)						
20cm	9.28ᵃ	17.97ᵃ	32.58ᵇ	10.48ᵃ	21.57ᵇ	36.48ᵃ
30cm	8.82ᵃ	17.46ᵇ	33.74ᵃ	9.97 ᵃ	20.71ᵇ	35.26ᵃ
40cm	8.97ᵃ	17.46ᵇ	32.73ᵇ	10.40ᵃ	22.60 ᵃ	36.71ᵃ
P>F	NS	*	**	NS	*	NS
LSD	0.4715	0.3926	0.3484	0.5456	1.4921	1.7008
Interaction						
VxS	NS	*	**	NS	NS	NS

NS= not significant. *= significant. **= highly significant.
WAS= weeks after sowing
NOTE: Values followed by the same alphabets are statistically not significant.

Table 3: Effects of Variety and Intra Row Spacings on Number of Capsules of Sesame in Yola and Dadin Kowa in 2016 wet season

	NC1		NC2		NC3		NC4		NC5	
Treatments	YL	DK	YL	DK	YL	DK	YL	DK	YL	DK
Varieties(V)										
NCRIBEN01M	3.68ᶜ	5.47ᶜ	3.16ᶜ	28.28ᶜ	7.75ᶜ	33.45ᵇ	16.11ᵇ	53.16ᵇ	32.48ᶜ	53.11ᶜ
NCRIBEN04E	6.31ᵃ	17.82ᵃ	9.40ᵃ	74.37ᵃ	16.77ᵃ	89.58ᵃ	18.09ᵃ	117.13ᵃ	89.98ᵃ	121.66ᵃ
E8	4.97ᵇ	8.68ᵇ	5.14ᵇ	39.51ᵇ	8.22ᵇ	26.03ᶜ	16.34ᵇ	43.93ᶜ	34.70ᵇ	74.37ᵇ
P>F	**	**	**	**	**	**	**	**	**	**
LSD	0.3073	0.3942	0.2077	0.6435	0.4151	0.6766	0.41	0.6376	0.3643	0.6583
Intra-row spacings(S)										
20CM	4.83ᵇ	8.68ᶜ	6.05ᵇ	38.71ᶜ	11.64ᵃ	46.78ᵇ	28.73ᵃ	72.33ᵇ	45.42ᶜ	86.43ᵇ
30CM	5.99ᵃ	10.30ᵇ	6.46ᵃ	39.56ᵇ	11.53a	57.02ᵃ	20.60ᶜ	79.92ᵃ	58.56ᵃ	66.76ᶜ
40CM	4.33ᶜ	13.01ᵃ	5.19ᵃ	63.90ᵃ	9.57b	45.26ᶜ	21.21ᵇ	62.77ᶜ	53.20ᵇ	95.95ᵃ
P>F	**	**	**	**	**	**	**	**	**	**
LSD	0.3073	0.3942	0.277	0.6464	0.4151	0.6766	0.41	0.6376	0.5615	0.6583
Interaction										
VXS	**	**	**	**	**	**	**	**	**	**

**= highly significant.
YL= Yola
DK= Dadinkowa
NC= Number of Capsules
NOTE: Values followed by the same alphabets are statistically not significant.

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Table 4: Effect of Variety and Intra Row Spacing on 1000 Seeds Weight (G) and Plot Yield (Kg) of Sesame in Yola and Dadin Kowa in 2016 wet season

Treatment	1000 seed weight (g)		Yield per hectare (Kg)	
	Yola	Dadinkowa	Yola	Dadinkowa
Varieties(V)				
NCRIBEN01M	3.08[a]	3.32[a]	666.89[b]	839.50[a]
NCRIBEN04E	3.31[a]	2.25[b]	802.49[a]	802.48[a]
E8	3.37[a]	2.25[b]	703.72[a]	703.71[a]
P>F	NS	*	*	NS
LSD	0.3377	0.2245	125.21	194.49
Intra-raw spacings(S)				
20cm	3.25[a]	3.27 [a]	666.69[a]	740.76
30cm	3.26[a]	3.28[a]	740.77[a]	839.51
40cm	3.25[a]	3.26[a]	765.44[a]	765.42
P>F	NS	NS	NS	NS
LSD	0.3372	0.2245	125.21	194.49
Interaction				
VXS	NS	NS	NS	NS

NS= not significant. *=significant
G= gram
KG= Kilogram
NOTE: Values followed by the same alphabets are statistically not significant.

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Response of Garden Cress (*Lepidium sativu* L.) to Sowing Method, NPK Compound Fertilizer and Irrigation Frequency

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Abstract

A field experiment was conducted at the Division of Agricultural Colleges Samaru, Ahmadu Bello University, Zaria (11⁰11'N; 07⁰38'E and 686m above sea level) in Northern Guinea Savannah ecological zone of Nigeria during the 2015 dry season to determine the response of Garden cress to sowing method, irrigation frequency and NPK fertilizer rate. Treatments consisted of two sowing methods (broadcast and drilling); two irrigation frequencies (3 and 5 day-intervals) and three levels of fertilizer rates (0, 30 and 60 kg NPK ha^{-1}) laid out in randomized complete block design and replicated three times. Results showed that broadcast planting recorded higher numbers of leaves and branches than drilling. The 3 - day irrigation frequency recorded taller plants and higher vegetable yield than 5 day interval. Application of 30 kg ha^{-1} NPK fertilizer produced taller plants and higher number of branches and vegetable yield than either zero or 60 kg ha^{-1} NPK fertilizer. . Other characters were not significantly affected by either irrigation interval or NPK fertilizer rates.

Keywords: Garden Cress, Sowing, NPK and Irrigation

INTRODUCTION

Garden Cress (*Lepidium sativum* L) is an annual erect edible herb and a member of the Brassicaceae family (Diwakar *et. al* 2010). Garden cress is popular to consumers and producers because of its peppery taste and content of health promoting substances such as glucosinolates and sterols (Tuncay *et. al* 2011). It is also known as pepper grass, pepper cress, mustard cress. Garden Cress is a leaf vegetable crop cultivated and harvested within a month for its succulent, pepperish and aromatic leaves. It is widely cultivated in temperate climates throughout the world for various culinary and medicinal uses (Gokavi *et.al* 2004). Garden Cress is believed to have originated in the highland regions of Ethiopia and Eritrea. Europe and western Asia were regarded as secondary centers of origin (Stchenkova 1932). It was being grown in Persia as early as 400BC. In Nigeria the cultivation of the crop is found in small quantities in the country. The genus Lepidium is made up of about 150 species, distributed throughout almost all temperate and subtropical regions of the world. Garden Cress is an annual, erect herbaceous plant, the flower coloration is white and the foliage color is medium green to dark green. The cress plant grows up to 50 – 80cm, with many branches on the upper part. It has white to pinkish flowers. Garden Cress is well suited to all soils and climates, although it does not tolerate frost. In temperate conditions, it has a very rapid growth rate. It can grow under full sun and partly under shade conditions and prefers cooler localities and higher altitudes (750 – 2900m) in tropical Africa. It has a very rapid growth rate it grows sub spontaneously in areas transformed by humans, close to crops or human settlements. Garden Cress is mainly used as an aromatic and to a lesser extent a pungent plant. The young leaves are used for salads; it is nowadays used in the seedling stage. The roots, seeds and leaves have been used as a spicy condiment. Medicinally garden cress roots have been used as a substitute for radish. The seeds are tonic, with expectorant activity and contain high concentrations of iodine, used to treat simple goiter. Garden cress has high oil content, (Moser *et al* 2009). Garden cress is a source of iron, folic acid, calcium, vitamin C, E and A. The seed contains arachidic and linoleic fatty acids. The leaves are also important source of vitamin A, C and foliate.

Garden cress has been produced and consumed in northern Nigeria. It is one of the under-exploited and neglected vegetable crops with shortest growing period and low input requirements. There is little documented literature garden cress production. Considering the medicinal and nutritional importance of garden cress, paucity of documented data on its production and ease of production, there is need to conduct research that will provide recommended agronomic practices for high productivity of garden cress. In line with these, this research was proposed to determine to determine appropriate sowing method , irrigation interval and NPK fertilizer rate for growth and vegetable yield of garden cress

MATERIALS AND METHODS

Field experiment was carried out at College of Agriculture teaching and research farm Samaru ($11^0$11'N; $07^0$38'E and 686m above sea level) located in the Northern Guinea Savanna agro-ecological zone of Nigeria during 2015 dry season (March - April). The aim was to study the response of garden cress to planting method, irrigation frequency and compound NPK fertilizer. Treatments consisted of two planting method (broadcast and drilling), two irrigation frequencies (3 and 5 day intervals) and three NPK rates (0, 30 and 60 kg ha^{-1}) replicated three times. The experiment was laid out in a Randomized Complete Block Design. Gross and net plot sizes were 1m x 1m and 0.5m x0.5m respectively. The experimental site was harrowed and all agronomic practices were followed. Parameters assessed included plant height (cm), leaf and branch numbers each at harvest, fresh weight and total vegetable yield. Data collected were subjected to analysis of variance analysis as described by Snedecor and Cochran (1967) using SAS software (SAS 9.3). Treatment means were compared using Least Significant Difference (Duncan, 1955)

RESULTS AND DISCUSSIONS

Table 1 contains treatments variations on plant height, numbers of leaves and branches per plant, fresh weight and vegetable yield of garden cress. Results show that broadcast sowing method produced taller plants with higher number of leaves and branches than drilled plants. It also recorded higher fresh weight and vegetable yield than broadcast planting. These enhanced vegetative growth, yield and quality of edible shoot of garden cress compared to drilling planting. This contradicts the findings of Idowu *et. al.* (2014) who reported that drilling was better than broadcast planting and attributed it to more favourable conditions for other crop management practices like fertilizer application, weeding, pest control, water application and harvesting compared to broadcast planting. The effect of irrigation frequency was significant on plant height and total vegetable yield of garden cress. The 3 day frequency registered tallest plants and out-yielded 5 day frequency. Other parameters evaluated were not significantly affected by irrigation frequency though 3 day frequency was still higher than 5 day irrigation. This implies that garden cress requires frequent irrigation expected as a vegetable crop with high water content. Jibrin (2013)reported similar findings. Application of inorganic NPK (15:15:15) fertilizer increased plant height (up to 60 kg NPK ha $^{-1}$), leaf and branch numbers per plant and fresh weight of garden cress up to 30 kg NPK ha $^{-1}$. Beyond which there was no significant increase in these parameters. Number of days to 50% flowering and total vegetable yield were no significantly affected by NPK fertilizer application. Babaji (2012) and Jibrin (2013) reported Lohard and Bory (1988) reported that NPK application enhanced growth and vegetable yield of garden cress and observed that leaf senescence was higher with zero NPK fertilizer application.

CONCLUSIONS

Based on the findings of this study, it can be concluded that broadcast sowing method was similar to drilling; 3 day irrigation frequency was suitable while application of NPK fertilizer at 30 kg ha^{-1} was optimum for growth and vegetative yield of garden cress.

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Moser B. R, Shah S. N; Winkler-Moser J. K.,Vaughn S. F, Evangelista R. L, (2009). Composition and physical properties of cress (*Lepidium sativum L.*) and FielD Penny Cress (*Thlaspi arvense L.*) *Oil Industrial Crops and Products* 30:199-205.

Table 1: Effect of sowing method, irrigation frequency and inorganic (NPK) fertilizer on performance of garden cress at Samaru, February- March, 2015

Treatment	Plant height (cm)	Leaf number	Branch number	Days to 50% flowering	fresh weight (g plant^{-1})	Total vegetable yield (t ha^{-1})
Sowing method						
Broadcast	8.17	33.91	7.67	28.58	1.39	97.86
Drilling	8.13	28.48	7.41	29.84	1.08	64.91
LSD	NS	NS	NS	NS	NS	17.944
Significance						
Irrigation frequency (days)						
3	8.86a	31.91	7.72	29.55	1.35	101.85a
5	7.44b	30.17	7.35	28.94	1.11	59.09b
LSD	0.756	NS	NS	NS	NS	41.772
Significance						
NPK (15:15:15) fertilizer F, (kg ha $^{-1}$)						
0	6.33c	26.54b	6.44b	29.41	1.00b	72.31
30	8.29b	31.32a	7.65a	29.25	1.20a	81.19
60	9.82a	35.27a	8.52a	29.08	1.48a	87.92
LSD	0.925	7.461	1.293	NS	0.469	NS
Significance						
Interaction						
S x I	NS	NS	NS	NS	NS	NS
S x F	NS	NS	NS	NS	NS	NS
I x F	NS	NS	NS	NS	NS	NS
S x I x F	NS	NS	NS	NS	NS	NS

Mean(s) followed by unlike letter (s) in a treatment group are not significantly different at 0.05% level significance; NS = not significant; * = significant at 0.05% level of significance.

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Influence of Effluent Sources and Rates on the Growth, Shoot Yield and Proximate Compositions of Amaranth (*Amaranthus cruentus*).

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Abstract
This study was conducted to evaluate the microbiological and chemical properties of some locally available effluent and to determine the appropriate rate of application for optimum growth and yield of amaranth during the 2015 cropping season at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso Oyo State. Seeds of indigenous amaranth were collected from the National Horticultural Research Institute, Ibadan, Oyo state, Nigeria. The effluents used were Fish pond, Domestic, Piggery and Industrial effluent. Effluents were applied at 0, 1500, 3000, 4500 and 6000 lha^{-1}. Experiment was laid out in 4 x 5 factorial fitted into a complete randomized design replicated six times. Data were collected on number of leaves, plant height, stems girth, leaf area, off shoot and shoot yield. Data were subjected to analysis of variance and significant means were compared using least significance difference at 0.05 probability level. Results showed that plant height, number of leaves, leaf area, offshoot of amaranth, E.coli count, helminthes count, Vitamin C, Beta-carotene and Crude fiber were significantly ($P< 0.05$) affected by effluent sources and rate. Across the effluent sources, piggery effluent consistently produced the highest growth parameters (stem girth = 177.55 cm; Leaf area = 45.38 cm^2, offshoot = 3.5 and fresh shoot yield = 13.38 g) at application rate of 4500 lha^{-1}, 3000 lha^{-1} and 4500 lha^{-1} respectively. However, industrial effluent increased the total coliform (0.77cfuml^{-1}) and Ascaris (2.00 ml/100 g) at application rate of 4500 lha^{-1} and 6000 lha^{-1} respectively. The study concluded that effluent sources and rate significantly affected amaranth growth and nutritional content. The use of piggery effluent at 4500 lha^{-1} gave the best performance of amaranth and is therefore recommended in the studied area.
Keywords: *effluent, shoot yield, nutritional content, chemical properties*

INTRODUCTION

Amaranth is one of the oldest food crops, with evidence of cultivation dating back as far as 6700 BC. Amaranth species have been important in different parts of the world and at different times for several thousand years. It is extensively cultivated, consumed and has high dietary value, (Akanbi and Toogun, 2002).

The increasing rates in global population shows a widening gap between the supply and demand for water and is reaching such an alarming level that in some parts of the world it is posing a threat to human existence. Since 1950 the world population has doubled while water consumption has increased by six folds and by 2025, it is expected that 3.4 billion people will be living in countries defined as water scarce. Rough estimate indicates that at least 20 million hectares of land in 50 countries are irrigated with raw or partially treated waste water (Van der Hoek *et al*., 2001). Scientists around the globe are working on new ways of conserving water. It is an opportune time to refocus on one of the ways to recycle water through the use of waste water for irrigation and other purposes.

Effluent refers to water whose quality might pose a threat to sustainable agriculture and or human health, but which can be used safely for irrigation provided certain precautions are taken. It describes water that has been polluted as a result of mixing with waste or agricultural drainage (Cornish *et al*., 1999). Any water that has been adversely affected in quality due to human activities can be regarded as effluent (Burton and Stensel, 2003).

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Effluents may be a combination of some or all of the followings; Storm water and other runoff, domestic effluent consisting of black water (excreta, urine and associated sludge), and grey water (domestic waste water), waste water from farm houses and fish ponds, reserved waste water from residences and water from commercial establishment and institutions, e .g. hospitals. The main sources of waste water are domestic and industrial. As a general rule 80-85% of water used is wasted. These waste effluents are released in the environment after treatment (developed countries) or mostly without treatment. These treatments are released into some water body or directly on the lands, which are mostly agricultural. Sometimes these effluent are purposely used for the irrigation due to scarcity of water especially for raising vegetables and fodder e.t.c. Priya *et al.* (2012), so there is common trend that industries dispose of untreated effluent through open and covered into the water ways which degrades water quality (Farid, 2003).

In many countries, water is becoming an increasingly scarce resource. Due to increasing population and industrial as well as urban expansion, the production of effluent and its reuse has grown rapidly. The major objective of effluent use is the effective utilization of its rich stock nutrient for agricultural purposes. These benefits also include conservation of water, provision of reliable water supply and recycling of nutrient, thereby reducing the need for chemical fertilizers, resulting in net cost savings for farmers.

Giving the high cost of fresh water in certain areas, farmers are forced to depend on waste water which is cheaper and more available. But there seems to be deficient in information on the effects of effluent irrigation on crop production.

The objective of the study was to assess the best effluent source and appropriate rate of effluent required for optimum growth, shoot yield and nutritional compositions of *Amaranthus* in the derived agro-ecological zone of Nigeria.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso Oyo State, Nigeria. Ogbomoso is located on longitude 4° 10' E and latitude 8º 10' N in the southern Guinea savannah zone of Southwest Nigeria. The temperature ranges from 28º C to 32º C with humidity of about 74% all year round except in January. Rainfall distribution is bimodal and the annual total rainfall ranges from 1250 mm to 1500 mm spanning through 8 months (March to October) with dry spell in August (Olaniyi, 2006).

Soil sampling and analysis

Precropping soil samples (0 - 15 cm) was collected with a soil auger randomly from the experimental area for physicochemical analysis (IITA, 1982).

Chemical and Biological Analysis of Effluent

Samples of each effluent used for the experiment were taken for chemical and biological analyses including Primary and secondary nutrient elements, namely; Nitrogen(N), Phosphorus (P), Potassium (K) as well as heavy metals, viz; Iron (Fe), Zinc (Zn) and Lead (Pb) concentration were determined using AOAC methods (AOAC, 1990), Total Coliforms E-Coli; Colphage and Ascaris, Helminthes were determined.

Treatments:

The indigenous amaranth which is widely cultivated, adapted and consumed in different ecological zones in Nigeria was used as test crop; the seeds were obtained from the National Horticultural Research

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Institute, Idi-Isin, Ibadan Oyo State, Nigeria.

Four effluents used are Fish pond effluent, domestic effluent, Piggery effluent and Industrial effluent. The piggery effluent was sourced from the Teaching and Research Farm, Ladoke Akintola University, Ogbomoso; the fish pond effluent was sourced from Aroje in Ogbomoso, the domestic waste was sourced from under G area of Ogbomoso while industrial effluent was sourced from Water Cooperation, Ede and Ilesha in Osun State.

Four effluents sources (fish pond, piggery, industrial and domestic) applied at five rates as follows; R_1 = control R_2 = 1500 lha^{-1} R_3 = 3000 lha^{-1} R_4 = 4500 lha^{-1} and R_5 = 6000 lha^{-1}.

Experiments were laid out in a 4 x 5 factorial experiment (with 20 treatment combinations) fitted into a complete randomized design (CRD) replicated six times. At planting, Amaranth seeds were sown in pot and the seedlings were thinned to two per pot. The treatment was applied 2 weeks after thinning and crops were allowed to grow for 8 weeks.

Data collection commenced at 2 weeks after thinning (WAT) and continued fortnightly till 8 WAT / flower initiation of Amaranth. Three plants were tagged per treatment for data collection. Growth parameters including number of leaves, plant height and stem girth; yield attributes, proximate and nutritional compositions of the plants were determined (AOAC, 1990).

The data collected was analyzed using procedures for general linear model, PROC GLM in SAS (SAS institute, 2011). Differences among treatment means were compared using the Least Significance Differences (LSD) at 0.05 probability level.

RESULTS

Chemical and biological composition of the effluents

N, P and K were highest in piggery effluent (4.45, 0.06 and 0.105, respectively) while industrial effluent had the lowest value of N and P (0.12 and 0.03), respectively however the lowest K was recorded in domestic effluents (0.01). Fe and Zn were highest in domestic effluent of (7.89 and 9.29, respectively) while piggery and industrial effluent had the lowest value of (4.73 and 3.44, respectively); Total coliform, *Escherichia coli* and Coliphage were highest in piggery effluent of (12.1, 8.2 and 3.0, respectively) while industrial effluent had the lowest value of total coliform and *Escherichia coli* (7.2, 4.1) and the lowest Coliphage was recorded in fishpond effluent (0.6). Similarly, Ascaris and helminthes count had their highest values (42.0 and 27.0) in piggery effluent while industrial effluent contained the lowest value (4.5) for ascaris while domestic effluent had the least value (5.0) of helminthes (Table 1).

Vegetative parameters

Number of leaves

Number of leaves of amaranth significantly differed by the effluent sources; at 2 weeks, piggery effluent 0.85 at rate 4500 lha^{-1} gave the highest number of leaves, followed by fish pond effluent 0.63 at 4500 lha^{-1}, while industrial effluent 0.42 at 0 l/ha gave the least number of leaves (Table 4.3). At 4, 6 and 8 weeks after sowing (WAS), there were no significant differences among the effluents and at 6 and 8 WAS piggery effluent gave the highest number of leaves of 22.20 and 40.33 at 6 and 8 WAS respectively while domestic effluent gave the least number of leaves (10.87 and 14.73, respectively). Rates of the effluents had significant effect on number of leaves across the weeks; rate 4500 lha^{-1} consistently produced the highest number of leaves while control

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pots had the lowest number of leaves across the weeks (Table 2).

Plant Height

Plant Height of Amaranth was significantly increased by the effluent at 2 WAS with piggery effluent which gave the highest value (17.30 cm) followed by fish pond effluent while industrial effluent gave the least height (8.83 cm) (Table 4.4). At 4, 6 and 8 WAS, there were no significant differences between the plant heights across the effluents. Plant height increased with increasing effluent rates; at 2 WAS, 4500 lha^{-1} resulted in the highest value (17. 30 cm) and control pots having the least height (8.83 cm). In addition, at 4, 6 and 8 weeks 4500 lha^{-1} still gave the highest values (25.65, 36.17 and 67.82, respectively) while control produced the least values of (12.63, 17.53 and 21.00 cm, respectively), Table 3.

Effect of effluent sources and rates on yield parameters of Amaranth

Stem girth was significantly improved by effluent resources at harvesting with piggery effluent recording the highest value (177.55 mm) while industrial effluent gave the least value (25.99 mm). Stem girth was not significantly improved by effluent rates applied at harvesting with 4500 lha^{-1} recording the highest stem girth while control gave the least value.

The effluent had no significant influence on leaf area although piggery effluent yielded the highest area (45.28 cm^2) while industrial effluent had the least leaf area (23.42 cm^2). There was no significant effect produced by the rates of effluents on the leaf area; 3000 lha^{-1} however produced highest while the least leaf area was obtained from control pots (0).

The offshoot of amaranth as affected by different effluents and their rates are presented in (Table 4.). Effluents and their rates had no significant effect on the number of offshoots produced by the plants with all rates and effluent sources producing 3.50 offshoots per plant.

Effluent sources and rates did not significantly influence the fresh shoot yield of amaranth; piggery effluent recorded the highest fresh shoot yield (13.60 g) while industrial effluent recorded the least shoot yield. In addition, 3000 lha^{-1}resulted in the highest shoot yield and control pots recorded the least shoot yield (5.50 g).

Proximate composition of Amaranth as influenced by effluent sources and rates

The proximate composition (CP, CF, FAT, ASH and CHO) of Amaranth were significantly influenced by the effluent sources; piggery effluent produced the highest crude protein (2.66) at 6000 lha^{-1} while lowest value was recorded from control pots (2.31). Fish pond effluent produced the highest Crude fiber content (1.60) at 6000 lha^{-1}while the least (1.39) was obtained from control pots. The highest fat content was recorded in pots treated with piggery effluent and domestic effluent (0.41) while control pots recorded the least value (0.23). Fishpond and domestic effluent recorded the highest ash contents (1.17) and PG recorded the least value (0.91). Industrial effluent had the highest carbohydrate contents (3221.13) at 1500 lha^{-1} while piggery effluent produced the least carbohydrate content (94.21). The proximate composition of (CP, CF, FAT ASH and CHO) content of Amaranth were significantly influenced by the rates applied. 4500 lha^{-1} recorded the highest value for CP, FAT and ASH (2.48, 0.38 and 1.18) and control pots recorded the least value (2.33, 0.26 and 1.06) while 6000 lha^{-1} recorded the highest value for CF (1.57) and control pots recorded the least value (1.43) 1500 lha^{-1} recorded the highest CHO content (876.3) and 6000 lha^{-1} recorded the least (94.3).

DISCUSSION

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The significant variations among the effluents with regards to their compositions corroborate the fact that their components differs. This in turn influenced their nutrient composition as well as the levels of heavy metal and biological constituent in each effluent. For instance, N, P and K were highest in piggery effluent expectedly because of the presence of organic matter in the feed and droppings of the pigs. However, the highest heavy metal level in domestic effluent possibly due to the utilization of various metallic tools. In addition, biological components were equally highest in piggery effluent and this might be attributed to decomposition state of the effluent that favours the proliferation of the microbes. This agrees with the work of Naddafi *et al.* (2005) who worked with two effluent sources and concluded that effluent components varied from one source to the other.

The inherent differences among the effluent sources further produced substantial differences in the vegetative parameters of amaranth. A similar observation was reported by Abegunrin *et al*. (2013) who worked with cucumber and used rainwater, kitchen wastewater and groundwater as water sources; they reported that the growth parameters of cucumber were significantly affected by the different water sources used for irrigation.

Generally, N favour vegetative growth in crops; hence the observed increase in vegetative parameters of amaranth where piggery effluent was applied follows from the high content of N in the piggery effluent (Kaushik *et al*., 2005). In addition, there were differences between the rates of the effluents used. Overall, 0 lha^{-1} of effluent resulted in the lowest values for the growth parameters. However, as the rates of the applied effluents increases there were increase in the growth parameters until a decline is observed at 6000 lha^{-1} of the evaluated effluents. This might point to the fact very high levels of effluent in the soil may have a negative influence on the growth of amaranth. Hayyat *et al*. (2013) however reported that growth of sorghum was negatively correlated to concentrations of effluent though they worked with textile effluent.

In general, domestic effluent consistently produced the lowest growth and yield parameters; this is not farfetched because analysis of the effluents has showed that it contains the lowest quantity of nutrients. Nevertheless, industrial effluent performed consistently better than domestic effluent for most of the growth and yield parameters despite the fact that domestic effluent was richer in nutrient than industrial effluent. This shows that the mineralization stages of these two effluents are different meaning that industrial effluent may readily releases the nutrient for plant use while domestic effluent may still have to further undergo decomposition before the nutrients can be made available for crop use.

The increase in proximate contents of amaranth at an increasing rate of effluent might be attributed to the increasing availability of the effluents aided continuous synthesis of the proximate contents by the amaranth plant. The use of fish pond effluent produced the highest crude fibre, fat and ash content in the amaranth tissues while piggery effluent yielded the best crude protein content. This may have occurred as a result of the nutrient components found in each effluent; piggery produced the highest crude protein content because it has high N content and N is a major component of protein molecules.

Generally production of Amaranth using effluent significantly affected the growth

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of amaranth; effluent has a potential to supply nutrients (N, P and K) to support plant growth (Singh *et al*., 2011) as it serves as a valuable source of plant nutrient and organic matter needed for maintaining fertility and productivity levels of soil (Rusan *et al*., 2007).

Nevertheless, it is recommended that risk assessment should be conducted prior to effluent irrigation to ensure the safe application of wastewater for landscape and agriculture and make its reuse safer.

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TABLE 1: Result of analysis of the effluents for N, P, K, heavy metals and biological constituents

Effluent	N	P	K	FE	ZN	Pb	TC	EC	CC	AS	HEL.C
IE	0.12	0.003	0.001	5.85	3.44	1.95	7.2	4.1	1.0	4.5	6.0
FP	0.18	0.013	0.016	6.92	4.56	2.46	8.3	5.1	0.6	10.0	11.5
PG	4.45	0.055	0.105	4.73	6.50	3.94	12.1	8.2	3.0	42.0	27.0
DE	0.56	0.006	0.07	7.87	9.29	2.72	10.6	5.2	2.3	8.0	5.0

IE = industrial; FP = Fishpond; PG = Piggery; DE = Domestic; N = Nitrogen; P = Phosphorous; K = Potassium; Fe = Iron (mg/l); Zn = Zinc (mg/l); Pb = Lead (mg/l); TC = Total coliforms (cfu/ml); CC = Coliphage count (cfu/ml); AS = Ascaris count (ml/100 ml); HEL.C = Helminthes count (ml/100 ml)

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Table 2: Effect of effluent sources and rates on number of leaves of Amaranth

	RATE OF APPLICATION (lha^{-1})					
EFFLUENTS	**0**	**1500**	**3000**	**4500**	**6000**	**Effluent Means**
			2WAS			
FP	0.5	0.58	0.61	0.63	0.59	0.58
DE	0.47	0.54	0.57	0.57	0.53	0.54
PG	0.53	0.69	0.76	0.85	0.71	0.71
IE	0.42	0.5	0.55	0.6	0.51	0.52
LSD EFF	0.08*					
LSD RATE	0.09*					
LSD R*E	Ns					
			4WAS			
FP	4.85	5.05	5.27	5.53	5.1	5.16
DE	4.9	5.22	5.42	5.57	4.97	5.22
PG	4.6	4.82	5.7	4.98	5.13	5.05
IE	5.1	5.22	5.52	5.88	5.42	5.43
LSD EFF	0.52ns					
LSD RATE	0.58ns					
LSD R*E	Ns					
			6WAS			
FP	13.47	15.67	16.93	19.32	16.12	16.30
DE	10.87	12.15	13.55	13.85	13.25	12.73
PG	11.72	17.1	19.87	22.2	20.95	18.37
IE	12.48	15.2	16.63	17.42	13.22	14.99
LSD EFF	4.48ns					
LSD RATE	5.01ns					
LSD R*E	Ns					
			8WAS			
FP	21.75	22.4	26.5	27.37	25.17	24.638
DE	14.73	18.08	20.08	20.97	19.27	18.626
PG	18.58	29.97	35.75	40.33	36.7	32.266
IE	15.47	18.07	26.78	25.95	19.6	21.174
LSD EFF	5.96*					
LSD RATE	6.66*					
LSD R*E	Ns					

* = data significant at $P \leq 0.05$; ns = data not significant at P 0.05; TRT = Treatment; IE = Industrial effluent; FP = Fishpond; PG = Piggery; DE = Domestic effluent.

Sample Table

Treatment	2WAS	4WAS	6WAS	8WAS
Effluents				
FP				
DE				
IE				
LSD(0.05)				
Rates(Lha^{-1})				
0				
1500				
3000				
4500				
6000				
LSD(0.05)				

Table 3: Effect of effluent sources and rates on height of plant of Amaranth

	RATE OF APPLICATION (lha^{-1})					
EFFLUENTS	0	1500	3000	4500	6000	Effluent Means
			2WAS			
FP	10.13	12.83	13.37	14.18	12.73	12.65
DE	9.18	9.98	10.82	11.2	10.03	10.24
PG	8.87	13.08	17.03	17.3	17	14.66
IE	8.83	9.75	10.72	12.33	9.7	10.27
LSD EFF	7.03*					
LSD RATE	7.87*					
LSD R*E	Ns					
			4WAS			
FP	13.88	16.85	18.75	19.55	17.82	17.37
DE	12.63	13.7	14.88	15.7	14.05	14.19
PG	12.92	19.25	23.1	25.65	22.92	20.77
IE	13.5	14	15.4	17.85	14.55	15.06
LSD EFF	3.6*					
LSD RATE	4.02ns					
LSD R*E	Ns					
			6WAS			
FP	18.32	23.48	23.85	24.9	22.37	22.58
DE	18.13	20.08	21.02	22.03	20.58	20.37
PG	19.62	27.32	33.52	36.17	31.73	29.67
IE	17.53	20.55	21.03	25	20.53	20.93
LSD EFF	3.9*					
LSD RATE	4.36ns					
LSD R*E	Ns					
			8WAS			
FP	34.63	38.07	41.15	42.75	40.15	39.35
DE	21	27.13	30.28	33.22	28.12	27.95
PG	33.48	51.3	66.38	67.82	57.1	55.22
IE	20.47	31.72	35.35	38.75	27.22	30.70
LSD EFF	4.44*					
LSD RATE	4.96*					
LSD R*E	Ns					

* = data significant at $P \leq 0.05$, ns = data not significant at P 0.05; TRT = Treatment; IE = Industrial effluent; FP = Fishpond; PG = Piggery; DE = Domestic effluent

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TABLE 4: Effect of effluent sources and rates on vegetative growth parameters of Amaranth

EFFLUENTS	RATE OF APPLICATION (lha^{-1})					
	0	**1500**	**3000**	**4500**	**6000**	**Effluent Means**
			LEAF AREA AT HARVEST (cm^2)			
FP	23.42	30.4	29.87	31.88	29.38	28.99
DE	24.02	24.8	26.75	29.37	25.62	26.11
PG	24.67	36.25	45.28	44.38	38.98	37.91
IE	24.35	26.23	29.73	31.35	23.87	27.11
LSD EFF	5.35*					
LSD RATE	5.98*					
LSD R*E	Ns					
			OFF-SHOOT PER PLANT			
FP	3.5	3.5	3.5	3.5	3.5	3.5
DE	3.5	3.5	3.5	3.5	3.5	3.5
PG	3.5	3.5	3.5	3.5	3.5	3.5
IE	3.5	3.5	3.5	3.5	3.5	3.5
LSD EFF	0.96ns					
LSD RATE	1.07ns					
LSD R*E	Ns					
			FRESH SHOOT YIELD AT HARVEST (g)			
FP	8.05	7.37	9.1	11.7	7.47	8.74
DE	5.68	6.58	6.78	8.15	6.07	6.65
PG	5.5	10.88	13.6	13.38	10.83	10.84
IE	5.62	7.12	6.25	8.52	4.18	6.34
LSD EFF	1.91*					
LSD RATE	2.14*					
LSD R*E	Ns					
			STEM GIRTH (mm)			
FP	43.32	64.81	74.27	72.06	60.69	63.03
DE	31.56	38.86	44.43	46.87	31.76	38.70
PG	57.59	90.46	151.26	177.55	119.92	119.36
IE	25.99	26.91	37.24	53.71	30.34	34.84
LSD EFF	21.67*					
LSD RATE	24.23*					
LSD R*E	ns					

* = data significant at $P \leq 0.05$; ns = data not significant at P 0.05; IE = Industrial effluent; FP = Fishpond; PG = Piggery; DE = Domestic effluent.

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Table 5: Effect of effluent sources and rates on proximate composition of Amaranth

	RATE OF APPLICATION (lha^{-1})					
EFFLUENTS	**0**	**1500**	**3000**	**4500**	**6000**	**Effluent Means**
			Crude Protein(mg/kg)			
FP	2.33	2.4	2.43	2.46	2.58	2.44
DE	2.32	2.45	2.47	2.50	2.54	2.46
PG	2.31	2.47	2.49	2.54	2.66	2.49
IE	2.36	2.4	2.42	2.45	2.56	2.44
LSD EFF	0.03*					
LSD RATE	0.03*					
LSD R*E	*					
			Crude Fiber(mg/kg)			
FP	1.49	1.51	1.55	1.57	1.60	1.54
DE	1.39	1.50	1.53	1.55	1.57	1.51
PG	1.40	1.48	1.51	1.54	1.58	1.50
IE	1.46	1.50	1.52	1.53	1.55	1.51
LSD EFF	0.08*					
LSD RATE	0.02*					
LSD R*E	Ns					
			FAT (g/kg)			
FP	0.31	0.32	0.34	0.36	0.38	0.34
DE	0.23	0.32	0.35	0.41	0.38	0.34
PG	0.23	0.32	0.34	0.40	0.41	0.34
IE	0.26	0.3	0.32	0.34	0.37	0.32
LSD EFF	0.02*					
LSD RATE	0.02*					
LSD R*E	*					
			ASH (mg/kg)			
FP	1.12	1.13	1.15	1.16	1.17	1.15
DE	1.06	1.09	1.12	1.28	1.17	1.14
PG	1.01	1.05	0.91	1.13	1.15	1.05
IE	1.04	1.12	1.13	1.14	1.16	1.12
LSD EFF	0.05*					
LSD RATE	0.05*					
LSD R*E	*					
			Carbohydrate (mg)			
FP	94.66	94.62	94.55	94.69	94.33	94.57
DE	95.00	94.64	94.54	94.45	94.35	94.60
PG	95.06	94.68	94.61	94.41	94.21	94.59
IE	94.89	3221.13	95.44	94.54	94.41	720.08
LSD EFF	554.79ns					
LSD RATE	620.28*					
LSD R*E	*					

* = data significant at $P \leq 0.05$; ns = data not significant at P 0.05; IE= Industrial effluent; FP = Fishpond; PG = Piggery; DE = Domestic effluent

General or specific comments

1. Please re-arrange your table and state your results and discussion appropriately
2. Consider revision to reduce the length of the article (8 pages recommended by the conference flyer)

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Effect of Weeding and Insecticidal Application on Fungal Load of Harvested Soybean Seeds

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Abstract
A field experiment comprising four weeding regimes and four levels of insecticidal application factorially combined and fitted in a randomized complete block design was carried out to determine their effects on seed mycoflora load of soybean at harvest. The different weeding regimes and insecticide application levels showed no significant consequence on mycoflora load of harvested seeds in treated plants. The different combinations of weeding and insecticide application however had significant effect ($p<0.05$) on the mean number of fungi isolated from the harvested seeds of soybean cultivar TGX 1448-2E. A combination of weeding (at least once) and insecticide application (at least twice) reduced fungal flora of the seeds most significantly ($p<0.05$). Aspergillus niger, Curvularia lunata and Penicillium oxalicum were the most affected fungal isolates. The mean number of Fusarium oxysporum and Phomopsis sp. were not significantly different throughout the experiment.
***Key Words**: Weeding, Insecticidal application, Soybean seeds, Fungal load*

INTRODUCTION

Soybeans represent the world's most important oilseed as a source of vegetable oil and protein. In Nigeria, the crop is becoming increasingly important as substitutes for protein from animal sources because it is cheap and affordable. Diseases can significantly affect yield level and quality of the crop. More than 135 microorganisms have been described on soybean, but only about 30 species belong to the group of economically important pathogens (Roy *et al*., 2000). Some of these pathogens are now known to be seed-borne in nature (Shovan *et al*., 2008). Seed-borne pathogens may cause disease or death of the plants resulting in crop and food loss and when stored for direct consumption, seed-borne organisms may cause chemical changes and deterioration or mycotoxin release with potentially harmful effect on humans and livestock (Chiarapa and Gambogi, 1986).

There are reasons to belief that seed infection by fungal pathogens takes place through weeds which serve as alternate host to the pathogens and also through insects that feed on the plant as well as those that pollinate the plant. Studies have shown that less seed infection by *Fusarium semitectum*, *Cercospora kikuchii*, *Phomopsis* spp., and *Rhizoctonia solani* occurred in plots where weeds were controlled compared to weedy plots (Bowman *et al*, 1986; Bradley *et al*, 2001; Chagas & Dhingra, 1979; Dhingra & Da Silva, 1978). Insects are particularly important in facilitating the entry of a pathogen into its host through the wounds they make on aboveground or belowground plant organs and in some cases they help the survival of the pathogen by allowing it to over-season in their body (Agrios, 2005). Dispersal of fungal spores by insects is recognized in many groups of fungi including *ascomycetes*, *basidiomycetes*, imperfect fungi and *zygomycetes* (Kendrick, 1985) as well as in slime moulds (Stephenson and Stempen, 1994). The objective of this study was to determine the effect of weed and insect control in soybean field on the fungal load of harvested seeds.

MATERIAL AND METHODS

Seeds of Soybean Cultivar TGX 1448-2E obtained from Shonga soybean farm in Kwara State was used for this study. The experiment was conducted at the Teaching and Research Farm of the University of Ilorin, located within the Southern Guinea Savannah ecological zone (9°29' N, 4°35' E) of Nigeria. The land was ploughed, harrowed twice and then ridged. Four seeds were planted per hole and the seedlings were thinned to two plants per stand after germination. The planting was done in June, 2015.

Treatment design

The following treatment combinations were tested on the field;

W_0I_0	W_1I_0	W_2I_0	W_3I_0
W_0I_1	W_1I_1	W_2I_1	W_3I_1
W_0I_2	W_1I_2	W_2I_2	W_3I_2
W_0I_3	W_1I_3	W_2I_3	W_3I_3

W_0I_0 (No weeding, No insecticide application); **W_0I_1** (No weeding, Insecticide application once); **W_0I_2** (No weeding, Insecticide application twice); **W_0I_3** (No weeding, Insecticide application thrice); **W_1I_0** (Weeding once, No insecticide application); **W_1I_1** (Weeding once, Insecticide application once); **W_1I_2** (Weeding once, Insecticide application twice); **W_1I_3** (Weeding once, Insecticide application thrice); **W_2I_0** (Weeding twice, No insecticide application); **W_2I_1** (Weeding twice, Insecticide application once); **W_2I_2** (Weeding twice, Insecticide application twice); **W_2I_3** (Weeding twice, Insecticide application thrice); **W_3I_0** (Weeding thrice, No insecticide application); **W_3I_1** (Weeding thrice, Insecticide application once);**W_3I_2** (Weeding thrice, Insecticide application twice)L **W_3I_3** (Weeding thrice, Insecticide application thrice)

The first weeding was effected by application of pre-emergence herbicide. Subsequent weed control measures involved manual removal of weeds either once, or twice after initial herbicide application during the active growing period of the plants.

Experimental Design

The experiment was a factorial fitted into a Randomized Complete Block Design. The land area used was 225m^2 with 0.5m alleyways within plots and 1m between the blocks. Each treatment combination was replicated thrice and each treatment replicate was randomly assigned to the plots.

Agronomic Practices

Glyphosate (the pre-emergence herbicide) was applied at the rate of 3litres/ha. Manual weeding by hoeing was repeated once and twice thereafter as appropriate. Control of insects was achieved with the use of Cypermethrine (2.5EC) applied at the rate of 500ml/500litre. Herbicide and insecticide applications were carried out using Knapsack sprayer. Insecticide was applied at seedling stage, just before flowering and at flowering/podding stages.

Harvesting

Harvesting was done by handpicking the mature pods from the plants. Harvested pods were packaged separately according to treatment combinations in labeled polyethylene bags and were moved to the laboratory for further processing and seed health testing.

Seed Health Testing and Incidence of the isolated fungi

This was carried out using the agar plate method as described in the International Seed Testing Association (ISTA, 1996) procedure. The seeds were pre-treated with 0.5% sodium hypochlorite for 30 seconds followed by rinsing in several changes of sterile water. The seeds were then plated on sterile Potato Dextrose Agar (PDA) medium amended with 1% streptomycin sulphate in petri dishes (9 cm diameter) at the rate of ten seeds per plate. Five replicate plates were used and the plates were incubated for seven days under twelve hours alternating cycles of light and darkness at 22 ^{0}C ± 2 ^{0}C . Incubated seeds were examined for mycelial growth and the fungal colonies were examined.

The incidence of each isolated fungus was determined as follows;

Percentage Incidence =

Number of isolated fungus

Total number of fungi isolated in the cultivar X 100

Identification of isolated fungi

Temporary slides were prepared for each of the isolates**.** The slides were then observed under a compound microscope (Olympus). The morphological and microscopic features were recorded. These features were matched with those described in standard references (Kulwant *et al*., 1994; Malone and Muskett, 1997; Mathur and Kongsdal, 2003) for identification of the isolates. The identities of the isolates were confirmed at the Plant Pathology Laboratory of the International Institute for Tropical Agriculture (IITA) Ibadan, Nigeria.

DATA COLLECTION AND ANALYSIS

Mean number of fungal isolates recovered from the soybean seeds were recorded for each of the treatment combinations. Analysis of variance was conducted using SPSS Version 21 statistical package. Where significant difference was recorded, the mean values were separated using the Duncan's New Multiple Range Test at 5% level of significance.

RESULTS AND DISCUSSION

The results showed that weeding alone had little or no significant consequence (p 0.05) on seed mycoflora load of treated plants (Figure 1). The same applied to insecticide application as a factor (Figure2). Weeding generally reduced the mean number of *A. niger* and *Phomopsis* sp. but the mean number of *C. lunata, F. oxysporum* and *P. oxalicum* increased with weeding only once. As the number of weeding increased, the mean number of these organisms isolated was reduced.

There is reason to belief that insects and weeds played important role in the composition of the mix of fungal flora associated with harvested soybean seeds in the field. Seedlings under the combined effect of insecticide application at least twice and weeding at least once in this study showed reduced fungal flora of the harvested seeds. The reason for this observation may be that the control of the insects had prevented fungal spore dispersal and the consequent seed infection.

Dispersal of fungal spores by insects is recognized in many groups of fungi including *ascomycetes*, *basidiomycetes*, imperfect fungi and *zygomycetes* (Kendrick, 1985) as well as in slime moulds (Stephenson and Stempen, 1994). No one particular taxonomic group of insects however, seems to be strongly associated with vectoring of herbaceous plant pathogens.

Another observation made in this study was that plots without weeding had seeds with significant infection with *A. niger*. No weeding treatment leading to significant increase in *A. niger* incidence on the seeds is an indication of the role of high moisture level inducing mouldy growth. It is to be noted that plots without weeding at all had higher level of weed population which must have significantly influenced the local humidity profile of the plant milieu. There is need for more literature to back up these results.

Insecticide application reduced the mean number of *Penicillium* sp. and *Phomopsis* sp. but the reduction was not significant (p 0.05). There was an initial increase in the mean number of *Aspergillus* sp., and *Curvularia* sp. with increase in the number of time insect control was carried out from once to twice. At the third

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application, the mean number of the organisms was eventually reduced

Different combinations of weeding and insecticide application had significant effect ($p<0.05$) on the mean number of *A. niger, C. lunata* and *Penicillium oxalicum* isolated from the seeds but not on the mean number of *Fusarium* sp. and *Phomopsis* sp. (Table 1). The lowest mean number of *A. niger* (0.33) was observed in the treatment combination involving weeding once-no insecticide, twice-insecticide once and thrice-insecticide once. *Curvularia lunata* had the lowest mean number (1.00) in treatment combination involving application of no weeding-insecticide thrice and weeding thrice-insecticide twice. *P. oxalicum* was completely eradicated with weeding thrice and insecticide application twice while *Phomopsis* sp. was completely eradicated with weeding once-insecticide twice, weeding thrice-insecticide thrice and weeding thrice-insecticide once.

Conclusion and Recommendations

Weeding and insecticide application as the main factors had no significant effect on the fungal load of the seeds of treated plants but the effect of combination of weeding and insecticide application was significant. Combination of insecticide application at least twice and weeding at least once will help to reduce fungal load of the seeds.

On the field, proper agronomic practices especially control of insect pests and weeds should be encouraged for effective control of seed-borne infection that may be carried from field to store.

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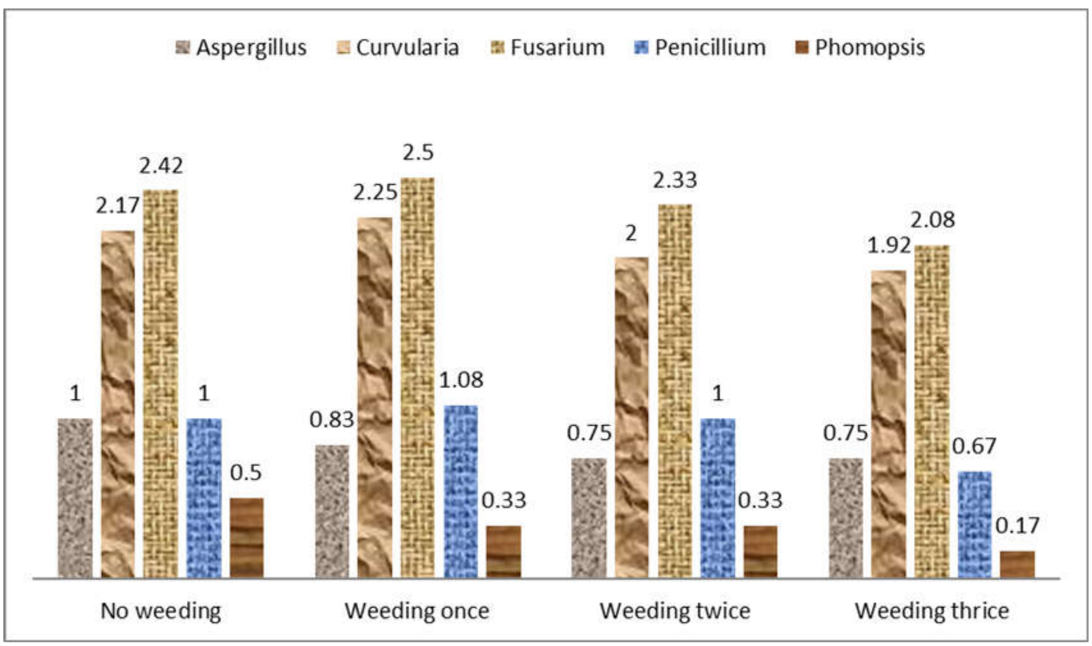

Figure 3: Effect of weeding on mean number of fungi isolated from soybean variety TGX1448-2E

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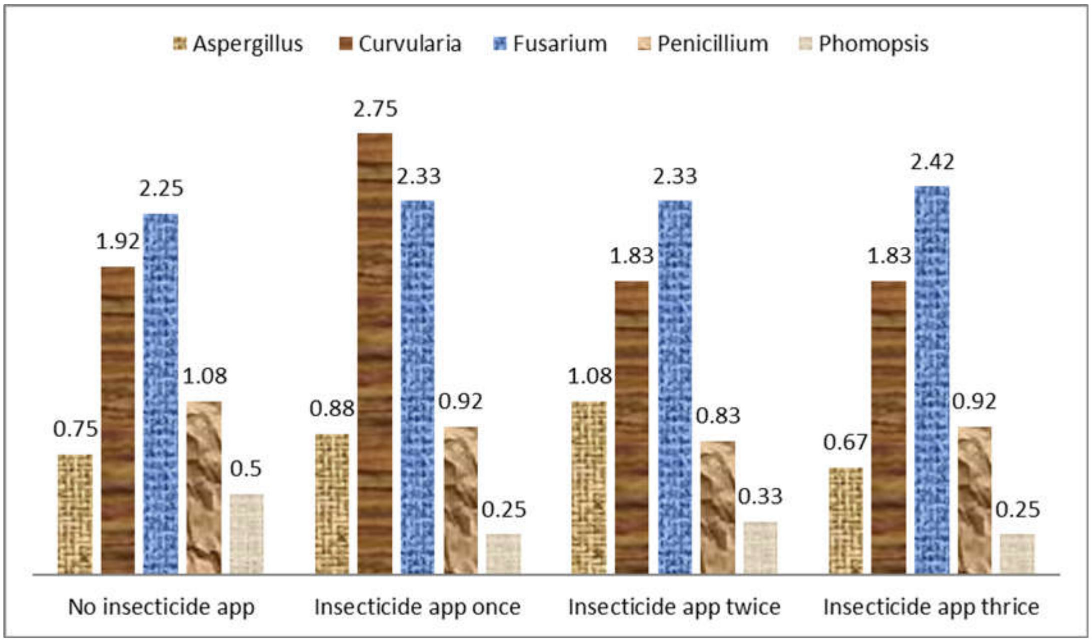

Figure 4: Effect of insecticide control on mean number of fungi isolated from soybean variety TGX1448-2E

Table 1: Effect of treatment combination of weeding and insecticide application on the mean number of fungi isolated from harvested soybean seeds.

Treatments	*A.niger*	*C.lunata*	*F.oxysporum*	*P.oxalicum*	*Phomopsis*
No weeding No insecticide	0.67^{ab}	1.67^{ab}	3.00	1.33^{a}	0.33
No weeding Insecticide once	1.00^{ab}	3.67^{a}	2.00	1.00^{ab}	0.33
No weeding Insecticide twice	1.67^{a}	2.33^{ab}	3.00	1.00^{ab}	0.67
No weeding Insecticide thrice	0.67^{ab}	1.00^{b}	1.67	0.67^{b}	0.67
Weeding once No insecticide	0.33^{b}	2.33^{ab}	1.67	1.00^{ab}	0.67
Weeding once Insecticide once	1.67^{a}	2.33^{ab}	3.00	1.33^{a}	0.33
Weeding once Insecticide twice	0.67^{ab}	2.00^{ab}	1.67	1.00^{ab}	0.00
Weeding once Insecticide thrice	0.67^{ab}	2.33^{ab}	3.67	1.00^{ab}	0.33
Weeding twice No insecticide	1.33^{ab}	1.67^{ab}	2.33	1.00^{ab}	0.67
Weeding twice Insecticide once	0.33^{b}	2.67^{ab}	2.00	0.67^{b}	0.33
Weeding twice Insecticide twice	0.67^{ab}	2.00^{ab}	2.33	1.33^{a}	0.33
Weeding twice Insecticide thrice	0.67^{ab}	1.67^{ab}	2.67	1.00^{ab}	0.00
Weeding thrice No insecticide	0.67^{ab}	2.00^{ab}	2.00	1.00^{ab}	0.33
Weeding thrice Insecticide once	0.33^{b}	2.33^{ab}	2.33	0.67^{b}	0.00
Weeding thrice Insecticide twice	1.33^{ab}	1.00^{b}	2.33	0.00^{b}	0.33
Weeding thrice Insecticide thrice	0.67^{ab}	2.33^{ab}	1.67	1.00^{ab}	1.00
	*	*	NS	*	NS

Values are means of five replicates

Values in the same column followed by the same letter(s) are not significantly different at p=0.05

*Significantly different at p=0.05

NS Not significantly different

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Antiviral Potential of Baking Soda in the Management of Amaranthus Mosaic Virus

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Abstract
Amaranth is an important vegetable containing very high amount of micronutrients and vitamins. Production of amaranth is limited by pests and diseases especially viruses and their insect vectors, thus reducing the market and nutritional qualities of the vegetable. The experiment was conducted at the experimental field of the Institute of Agricultural Research and Training, Ibadan, Nigeria to study the antiviral potential of baking soda in the management of Amaranthus mosaic virus. The study involved the spraying of A. cruentus at 2 and 4 weeks after planting (WAP) with the following treatments; baking soda (BS) alone; cypermethrin alone; mixture of BS and half dose of cypermethrin, and untreated control. Incidence and severity of Amaranthus mosaic virus (AMV) were determined as well as the weed species dominating the treated plots. Results revealed that the combination of BS and cypermethrin produced the highest plant height with values of 17.5 cm and 66 cm at 3 and 5 WAP respectively. Leaves were severely damaged in the untreated control plants compared with the treated plants. Reduced virus incidence were obtained when BS or its mixture with cypermethrin were used. A total number of seven weed species dominated the plots. Baking soda or their combinations with synthetic pesticides efficiently reduced the incidence and severity of AMV in A. cruentus.
***Key words**: Amaranth, Disease, Incidence, Pesticide, Amaranthus mosaic virus*

INTRODUCTION

Amaranthsare leafy vegetables which belong to the family Amaranthaceae. Amaranths are nutrient rich foods which improve food security and reduce malnutrition in African communities that solely depend on subsistence agriculture (Emire,and Arega, 2012).Insects pose a serious threat to amaranth growers (Palou*et al*., 2001) and some of these insects transmit viruses to cultivated crops. Pesticides are used for the control of insects but they are toxic to humans and the environment. Therefore, there are needs for alternatives which are Generally Recognized asSafe (GRAS). Studies have shown the effectiveness of salts in the control of various pathogens of many crops (Grubben, 2004; El-Mougy and Abdel-Kader, 2009). The benefits of baking soda (sodium bicarbonate; $NaHCO_3$) for the management of several plant diseases havebeen reported (Kuepper *et al*., 2001). Sodium bicarbonate is one of the registered biopesticides by Environmental Protection Agency in USA.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of the Institute of Agricultural Research and Training, Ibadan, Nigeria. It consisted of four treatments; i) plots sprayed with 7.5 ml/L of cypermethrin (synthetic pesticide), ii) plots sprayed with 15 g of baking soda (BS) suspended in 1.0 L of tap water, iii) plots sprayed with 3.75 ml of cypermethrin and 7.5 g of BS; both suspended in 1.0 L of tap water and iv) unsprayed plot (control) replicated three times and laid out in Randomized Complete Block Design. Seeds of *Amaranthuscruentus*(NHAc3) were obtained from the National Horticultural Research Institute, Ibadan, Nigeria. Seeds were sowed by drilling on 1 m x 1m bed. After germination, the seedlings were thinned to a spacing of 20 cm x 20 cm andfour plants were tagged per bed. First

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spraying was carried out 2 weeks after planting (WAP) and data collected 1 week after spraying which is equivalent to 3 WAP. The second spraying was carried out 4 WAP and data collected 1 week after spraying which is equivalent to 5 WAP.

Plant height was determined using a meter rule to measure the height of the plants from the base to the apex, Number of leaves was determined by counting the total number of leaves on each plant, Virus incidence was determined by counting the number of virus infected plants and expressing it as a percentage of the total number of plants on each plot. The determination of leaf damage and virus severity was on a scale of 1 to 5 with 1 representing absence of leaf damage/virus infection and 5 representing very severe leaf damage/very high virus infections.

Weed species that emerged from the plots were counted and identified; this is to study the effect the various treatments have on weed species diversity and abundance. The weeds were identified to species level using Akobundu (1987).

Data obtained were subjected to statistical analysis of variance using Statistical Package for Social Sciences (SPSS). New Duncan multiple range test was used to separate means at $P \leq 0.05$. Pearson correlation was used to determine the relationship between measured parameters and disease traits.

RESULTS

Effect of baking soda and cypermethrin on agronomic parameters (plant height and number of leaves) of *Amaranthus cruentus*

The results obtained at 3 WAP revealed that spraying at 2 WAP with mixture of cypermethrin and baking soda (BS) had significantly highest plant height (17.55 cm) while there was no significant difference in the heights of plants sprayed with cypermethrin only (15.33 cm) and baking soda only (11.53 cm).The control had the least plant height of 10.07 cm. The treatments did not have any significant effect on the number of leaves of *A. cruentus* at 3 WAP, however, mixture of cypermethrin and baking soda had the highest (9.67) number of leaves while cypermethrin only had the least (8.03) (Table 1).

At 5 WAP, results showed that the mixture of cypermethrin and BS produced the tallest plant (66 cm) and was significantly different from the other treatments which were at par. Similar trend was observed in the number of leaves (Table 1).

Effect of baking soda and cypermethrin on disease traits of *Amaranthus cruentus*

Virus incidence was greatly reduced at 3 WAP to a mean value of 1.33% when baking soda was combined with cypermethrin compared to the control plant which had a mean incidence of 36.67%. The mean Amaranthus mosaic virus (AMV) incidence in baking soda-treated plant was 16.67%. There was no incidence of AMV in cypermethrin-sprayed plants at 3 WAP (Fig.1). Also, there was no incidence of AMV in plants sprayed with cypermethrin alone at 5 WAP. However, low incidences of 8.33% and 6.67% were obtained from plants sprayed with BS only and plants sprayed with mixture of BS and cypermethrin, respectively. Incidence of 25% was recorded for the control plants (Fig. 1).Insect damage was severe (2.67)on the leaves of the control plants at 3 WAP while the least leaf damage (1.67) was obtained when cypermethrin alone was used. Baking soda alone and its mixture with cypermethrin had a severity of 2. At 5 WAP, leaves were severely damaged (4.0) in the control plants while mild to moderate leaf damage was recorded in plants sprayed with BS only and mixture of BS and cypermethrin (Fig. 2). At 3 WAP, AMV severity in plants sprayed

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with BS and its mixture with cypermethrin was mild. At 5 WAP, the control plants had the highest AMV severity of 3 while the plants that received baking soda andits combination with pesticide treatment had severity of 2 (Fig. 3).

Relationship between plant growth parameters and disease traits

There was no significant correlation between plant growth parameters and disease traits at 3 WAP. A positive and significant (0.686*) relationship existed between leaf damage at 3 WAP and virus severity at 3 WAP. There was a significant correlation between disease traits at 3 WAP and disease traits at 5 WAP. Plant height at 5 WAP significantly correlated with number of leaves at 1% level of probability. The correlation between leaf damage and virus disease traits was positive and significant (Table 2).This implies that leaf damage could predispose plants to virus infections.

Occurrence of weed species in *Amaranthus cruentus* field

Plots that were sprayed with cypermethrin mixed with baking soda had the most weed species abundance. The least weed populations were recorded from plots sprayed with baking soda alone, this may suggest baking powder as a weed control agent. The treatments had no effect on weed species diversity as most weeds observed on the plots cuts across all treatment combinations. *Oldenlandia diffusa* had the least population and was observed only on plots sprayed with cypermethrin mixed with baking soda.

DISCUSSION

The study revealed that growth parameters were improved by baking soda. Greg and Williams (1993) reported that 2% baking soda and 1% oil solutionproved most effective in controlling plant disease. This suggests that when plant diseases are controlled, plant growth will improve. The low incidence of AMV in *A. cruentus* sprayed with baking soda or its mixture with cypermethrin as compared with the unsprayed control suggests that baking soda is a good antiviral substance. Palou *et al*. (2001) have reported the effectiveness of salts such as sodium bicarbonate in the control of various pathogens of many crops.The severe damage on the leaves of the unsprayed plants could be attributed to the non-persistent nature of AMV transmission by *Aphid* species. Taiwo and Owolabi (2004) have reported that the commonest methodof AMV transmissionon the field was by insect transmission. The severity of leaf damage was reduced in plants sprayed with mixture of baking soda and cypermethrin. This agrees with the report of Abdel-Kader *et al*. (2012)which stated that combination of baking soda with chemical fungicide gives a better control in foliar disease than baking soda alone. The reduced severity of AMV in plants that were sprayed with baking soda and cypermethrin confirmed the study of Ziv and Zitter (1992) which reported the use of sodium bicarbonate for the control of cucurbit foliar diseases.The high number of weed species on the plot sprayed with mixture of baking soda and cypermethrin is an indication that the mixture provided a suitable environment for the weeds to thrive. The growth of wild plants within an agricultural field or in close proximity can serve as sources of inoculums or reservoirs of viruses to economical crops (Duffus, 1971).

CONCLUSION

This study concludes that half dose of synthetic pesticide mixed with baking soda for the management of pests and Amaranthus mosaic virusof *A. cruentus* gives maximum control. Baking soda alone can also be used for the control of viruses and their vectors for sustainable food production and security.

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Table 1. Effect of baking soda and cypermethrin on plant height and number of leaves of *Amaranthus cruentus*

	3 WAP		5 WAP	
Treatment	**Plant height (cm)**	**No. of leaves**	**Plant height (cm)**	**No. of leaves**
Cypermethrin	15.33^{ab}	8.03	33.75^{b}	14.50^{b}
Baking soda	11.53^{ab}	8.92	40.17^{b}	14.67^{b}
Cypermethrin + Baking soda	17.53^{a}	9.67	66.00^{a}	20.67^{a}
Control	10.07^{b}	8.83	30.83^{b}	11.83^{b}
NDMRT		NS		

Means followed by the same letter along the column are not significantly different according to New Duncan's multiple range test (NDMRT) at $P \leq 0.05$.

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Table 2. Correlation between plant growth parameters and disease traits in *Amaranthus cruentus*

Variable	1	2	3	4	5	6	7	8	9	10
1	1	0.436^{ns}	0.40^{ns}	0.075 ns	0.22^{ns}	0.374^{ns}	0.275^{ns}	0.267^{ns}	0.37^{ns}	0.6*
2		1	0.152 ns	0.057 ns	0.167^{ns}	0.393^{ns}	0.103^{ns}	-0.003^{ns}	0.19^{ns}	0.432ns
3			1	0.407 ns	0.686*	0.039^{ns}	-0.125^{ns}	0.669*	0.706*	0.621*
4				1	0.574^{ns}	-0.541 ns	-0.662*	0.787**	0.829**	0.713**
5					1	0.187^{ns}	0.081^{ns}	0.683*	0.688*	0.672*
6						1	0.898**	-0.222^{ns}	-0.245^{ns}	-0.071^{ns}
7							1	-0.344^{ns}	-0.381^{ns}	-0.181^{ns}
8								1	0.923**	0.606**
9									1	0.800**
10										1

*Significant at 5% level of probability, **significant at 1 % level of probability, ns = not significant

1, 2, 3, 4 and 5 = Plant height, number of leaves, leaf damage, virus incidence and severity respectively at 4 weeks after planting.

6, 7, 8, 9 and 10 = Plant height, number of leaves, leaf damage, virus incidence and severity respectively at 6 weeks after planting.

Table 3. Distribution of weed species in *Amaranthus cruentus* field

Weed species	Cypermetrin	Baking soda	Cypermethri+Baking soda	Control
Cyperus rotundus	12	15	11	10
Celosia	10	12	10	8
Commelina bengalensis	10	8	7	12
Tridax procumbens	15	14	15	17
Phyllanthus amarus	11	10	18	15
Cynodon	17	12	17	10
Oldehlandia	-	-	12	-
Total	75	71	90	72

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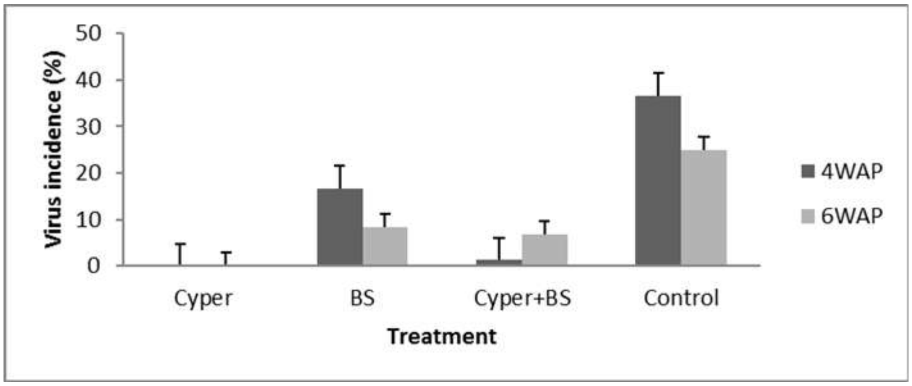

Fig. 1. Virus incidence in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

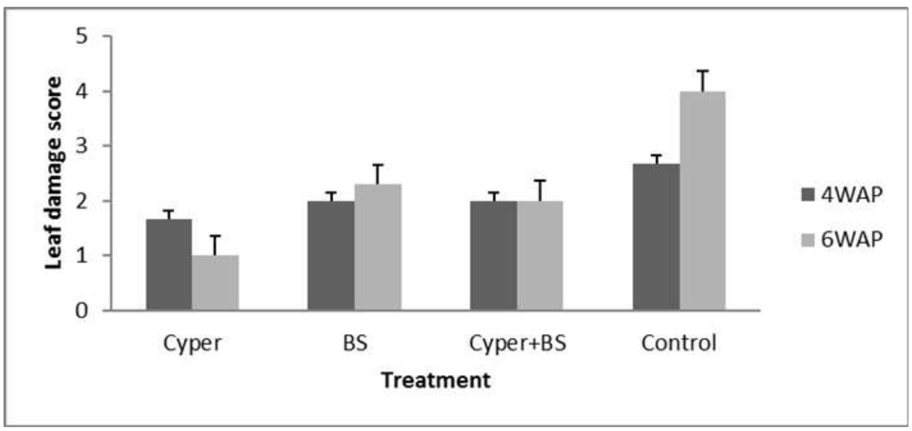

Fig. 2. Leaf damage in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

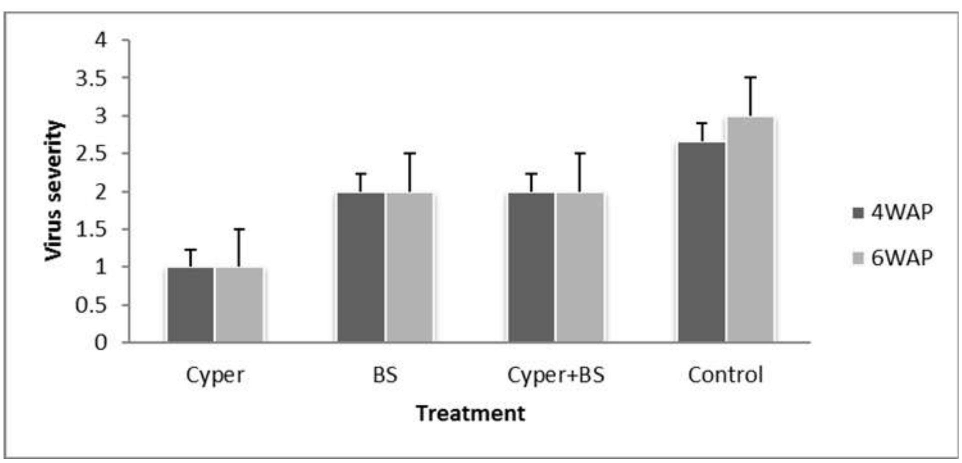

Fig 3. Severity of virus in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

The Effect of Spacing Variations on the Growth and Yield of the Fluted Pumpkin (*Telfaria occidentalis* Hook. F.) in Lafia, Nasarawa State

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Abstract
This study was carried out to assess the growth performance of the Fluted pumpkin vegetable, Telfairia occidentalis at the Demonstration Field of Faculty of Agriculture (Shabu-Lafia Campus), Nasarawa State University, Keffi. Parameters measured were plant height, leaf count, number of branches, leaf area, stem girth and yield (fresh and dry weight) as influenced by varying plant spacing of fluted pumpkin. . The treatments included factorial combinations of inter and intra row spacing of 0.25 x 1, 0.5 x 0.5, 0.5 x 0.75, 0.5 x 1 and 0.75 x 1m, respectively arranged in randomizes complete block design (RCBD) and replicated 3 times. Five (5) randomly selected tagged plants in each net plot were used for periodic observations during the crop growth period at 3, 6, 9 and 12 weeks after sowing (WAS). The results obtained showed a significant difference in the effect of plant spacing across all traits studied. The results of T. occidentalis collected on the bases of plant spacing revealed that 12 WAS had the highest mean value for all traits which signifies that, the longer the plant stay on the field, the more it produces with attendant increase in leafy vegetable yield. The study revealed that the wider plant spacing of 0.75 x 1.0 m could be adopted as the best for the production of leaves and bigger leaves as this is the ultimate production of the crop among poor resource farmers for economy.
Keywords*: Fluted pumpkin, T. occidentalis, Vegetable, Spacing, Growth*

INTRODUCTION

Fluted Pumpkin, *Telfairia occidentalis* belongs to the genus *Telfairia*, Tribe Jolffeae, sub- family Cucurbiloideae, and family Cucurbitaceae (Akoroda, 1990). Fluted Pumpkin has about 90 genera and more than 70 species distributed all over the warm parts of the world (Axtell, 1992). *Telfairia occidentalis* is a dioecious, creeping perennial vegetable shrub that spread low across the ground and climbs by means of befit and often coiled tendrils (Okoli and Mgbeogwu, 1983; Horsfall and Spiff, 2005). The crop is recalcitrant in nature and seed storage is poor. The female plants are much desired by consumers and producers because of its succulent large leaves and the fact that it produces the pods. The female flowers are similar to male flowers but with inferior, cylindrical, 3-ceiled ovary and three large heart shaped stigma. The male to female plant flowers varies ranging between 0.17 - 1.10 and 1.00 - 1.10 (Onwueme *et al*., 1986, Anyim and Akoroda, 1983). The crop does well in heavy rainfall area and late planting does not favour its production because the dry season, will not allow extension of the period of crop production except when irrigated (Odiaka *et al*., 2008). Rainfall appears to be the major factor in its production with a requirement of 1000 – 2500 mm per annum (Akoroda, 1990). It has been reported that the crop thrives well within temperature range of 30° – 50°C (Ossom *et al.,* 1997). The crop prefers a loose, friable soil with ample humus and shaded position (Muoneke *et al*., 2011).

Telfairia occidentalis commonly called fluted pumpkin or fluted gourd but locally called Ugwu (Igbo), Iroko or Apiroko (Yoruba) and Ubong (Efik), Ikong (Ibibio), Umee (Urhobo) and Umeke (Edo); and is indigenous to southern Nigeria and grows in the forest zone of West and Central Africa (Nigeria, Ghana and Sierra Leone being the major producers) (Akoroda, 1990). The crop is

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reported to have originated in south East Nigeria and distributed by the Igbos who have been cultivating this crop since time immemorial (Akoroda, 1990; Schippers, 2000) and its cultivation has spread into the Northern Guinea Savannah and has blend with the cultures of the people in the area who have found various usefulness for the fruits and leaves (Odiaka *et al*., 2008). Fluted pumpkin is commonly grown in mixture with some staple food crops such as cassava, yam, maize and other tropical vegetables; although, in recent times, pure fluted pumpkin stands are becoming more common in Nigeria for market gardening and for economy (Schippers, 2000).

In Nigeria, the crop is commonly grown for the leaf and seed, especially in the South-Eastern and Southern Nigeria. The succulent leaves, shoots and the seeds are consumed as vegetables by humans and as forage by livestock (Badifu and Ogunsua, 1991; Akwaowo *et al.,* 2000). According to Oyolu (1980) the leaves and edible shoots of the crop together contain 85% moisture; while the dry portion of what is usually consumed contains 25% carbohydrate, 11% crude protein, 3% fat, 4.32% potassium, 0.58% phosphorus, 0.56% magnesium, 0.47% calcium and 700 ppm iron. The seeds contain 20.5, 45, 32.2 and 4.8 g/100 g protein, fat, carbohydrate, fibre and total ash, respectively (Tindal, 1986; Badifu and Ogunsua, 1991). Anti-nutrients such as phytic acid, tannin, oxalic acid, hydrocyanic acid and saponins have also been noted to be constituents of the plant (Akwaowo *et al.,* 2000; Ajibade *et al.,* 2006).

The edible and succulent part of the crop include young and tender shoots, leaves, petioles, fruits and seeds that are usually cooked in preparing soups (Schippers, 2000) and sauce for eating with garri and foofoo meals (cassava meal) and sometimes usually cooked lightly with okra and fish or meat. The young shoots and leaves are more importantly used because of its pleasant taste and the nutritional benefits derived from them (Giami, 2003). The seeds can also be eaten whole, ground or fermented into 'ogiri' (Achi, 1999) which serves as condiment for making soup and sauce (Asiegbu, 1983). The fruit pulps which constitute 64% of the whole fresh fruits weight can be used as feedstuff for livestock (Essien *et al*., 1992). Generally, *T. occidentalis* is an important vegetable crop that has high nutritional and commercial value (Schippers, 2000). It is usually used in African traditional herbal medicine for the treatment of anaemia in view of its high ferrous content (Aiyalaagbe, 2011) and in the treatment of cough, diarrhea, tuberculosis and other bacterial infections (Egbomeji *et al*., 2006). The high oil content makes it a potential source of raw materials for the vegetable oil industries in Nigeria, for making margarine and these justify the apparent increase in its production in Nigeria (Odiaka *et al.,* 2008). The seeds are also in high demand for consumption by nursing mothers because of its lactation promoting properties, owing to the high concentration of essential fatty acids and poly unsaturated fatty acids and iodine. The oil is also used for hair treatment (Bird, 2003).

Several reasons are responsible for low yield per hectare of vegetable production, among which are plant geometry, fruit harvest intervals and other crop husbandry activities. It has been observed that suitable plant spacing can lead to optimum vegetable yield while wrong plant spacing could result in relatively low yield (Maurya *et al*., 2013). Inter and intra row spacing are important agricultural factors and have great effect on fruit yield and yield components in plants (particularly fruits and vegetables) (Law-Ogbomo and Egharevba, 2008). Spacing alters plant architecture, photosynthetic efficiency of leaves, fruits size and fruits production pattern. According to Heuelink *et al.* (2007) too narrow and too wide spacing do affect crops yield through competition and

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shading effect. So it is imperative to develop inter and intra row spacing recommendations which may help to utilize the resources more effectively and efficiently towards increased production, productivity and fruit and leave qualities (Ara *et al.,* 2007). Understanding the crop response to plant density is crucial for maximum yield. Moniruszaman (2006) indicated that plant population or density is among factors that affect yield and quality of crops. The aim of this study is therefore, to assess the growth performances of fluted pumpkin, *Telfairia occidentalis* Hook F. as affected by different plant spacing while the specific objectives are to: assess the growth and performance based on plant height, leaf count, number of branches, leaf area, stem girth as influenced by varying plant spacing and also to assess the yield of fluted pumpkin leaves based on fresh weight and dry weight as influenced by varying plant spacing**.**

MATERIALS AND METHODS

Location of the Study Area

The study was conducted at the demonstration field of Faculty of Agriculture (Shabu,-Lafia Campus), Nasarawa State University, Keffi. The area lies on Latitude 08^{o} 33^{1}N, Longitude 08^{o}, 33^{1}E and at an altitude of 181.53 m above sea level (Jayeoba, 2013). The mean annual rainfall of the region is about 1132 mm. The mean temperature ranges between 24.80°C and 33°C as minimum and maximum, respectively. Lafia has a population of 330,172 (NPC, 2006).

Treatments and Experimental Design

The treatment combinations include inter and intra row spacing of 0.25 x 1 m, 0.5 x 0.5 m, 0.5 x 0.75 m, 0.5 x 1 m and 0.75 x 1 m. The treatments were arranged using a randomized complete block design (RCBD) with three replications, respectively, having a total of 15 treatments. The gross plot size was 4 x 4 m with experimental blocks and plots spaced at 1.5 and 1 m apart, respectively.

Cultural Practices

The field was cleared of vegetation, stumps and debris, and was ploughed traditionally with the use of a hoe. The field was marked into plots and blocks. Seeds of *Telfairia occidentalis* was obtained from pods collected from local variety among farmers. The seeds were treated with insecticide-fungicides mixture formulated as Apron+ to prevent attack by insects and fungi. Sowing of seeds was done immediately after treatment, at the depth of 3 - 4 cm. Weed control in each experimental plot was carried out manually with the use of traditional hoe at two weeks after sowing (WAS) and subsequently as the need arose. Staking was done at 4 weeks after germination using bamboo sticks with trellis. Harvesting of the leaves was done at 12 WAS using sharp knife.

Data Collection

Data collection was taken on five randomly selected and tagged plants in each net plot and used for periodic observations during the crop growth period at 3, 6, 9 and 12 (WAS) to determine growth parameters such as plant height (taken with a measuring tape from ground level to the tip of main shoot), number of leaves per plant (determined by carefully counting the number of leaves of tagged plants), number of branches per plant, stem girth (taken at 5 cm above the ground level and this was measured with Vernier Caliper), leaf area (was determined following the proposition of Prof. Jayeoba for calculating leaf area for *T. occidentalis* {personal communication} as follows: $Y = 0.0002(LxW)^3 - 0.0175(LxW)^2 + 1.1819(LxW) + 2.2103$ (0.78); where Y = leaf area; L = length; W = breadth), and yield (fresh and dry leaf weights were determined at 12 WAS and the leaves were harvested and weighed with digital weighing scale to obtain the total fresh weight. Thereafter, the sample taken was oven- dried and re-weighed to obtain

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sample dry weight). All data taken were summed up and there means recorded.

Data Analysis

Data obtained was subjected to analysis of variance (ANOVA) and analysed with Genstat (2007) software package, while significant differences between the means were separated using the Least Significant Difference ($P \leq 0.05$) statistic.

RESULTS

The effect of plant spacing on plant height showed that at 3 WAS there was significant difference between spacing of 0.25 x 1 m and 0.75 x 1 m ($P<0.05$), also 0.5 x 1 m and 0.25 x1 m was statistically different from each other, while the remaining treatments were not-statistically different ($P>0.05$) from each other. At 6, 9 and 12 WAS, the results showed that there were no statistical differences ($P>0.05$) among the treatments, however, spacing of 0.25m x 1m had the highest plant height, respectively (Table 1).

Table 2 shows the effect of plant spacing on the development of stem girth of fluted pumpkin over a twelve week duration period. The results showed that there were no significant differences ($P\geq0.05$) among all the treatments. However, numerically, 0.5m x 0.5m had the highest plant girth at 3, 6 and 9 WAS and 0.5m x 0.75m spacing had the highest girth at 12 WAS.

The effect of plant spacing on the number of branches produced by fluted pumpkin grown over a twelve week period is shown in Table 3. The results showed that at 3 WAS there was significant difference ($P<0.05$) between the treatments. There were however, no significant differences ($P>0.05$) among the treatments at 6, 9 and 12 WAS with plant spacing of 0.5m x 0.75m having the highest number of branches at 6 and 12 WAS while 0.75m x 1m had the highest at 9 WAS.

The results of the effect of plant spacing treatments on the number of leaves produced by fluted pumpkin at 3 and 12 WAS showed that there was significant difference ($P<0.05$) between treatments while 6 and 9 WAS showed that there were no statistically significant differences ($P>0.05$) between the treatments (Table 4). Plant spacing of 0.5 x 0.5m had the highest number of leaves at 3 and 6 WAS while spacing of 0.5 x 0.75m had the highest at 9 and 12 WAS.

The results of the effect of plant spacing on leaf area of fluted pumpkin are shown in Table 5. The result showed significant difference in the treatments at 3, 6, 9 and 12 WAS. At 3 WAS, spacing of 0.25m x 1m had the highest leaf area (35.40 cm^2) while spacing of 0.75m x 1m had the highest leaf area at 6, 9 and 12 WAS with values of 72.30, 122.00 and 153.2 cm^2, respectively. Spacing of 0.5m x 0.75m had the least values of leaf area all through the weeks.

The results of the Biomass fresh and dry weight at 12 WAS showed that there was no significant difference ($P>0.05$) between all the treatments. However, spacing of 0.75m x 1m had the highest (0.275 Kg) fresh weight and (0.0830 Kg) dry weight, values while 0.5m x 0.5m spacing had the least values (0.203 and 0.0720 Kg) of fresh and dry weight, respectively.

DISCUSSION

The study revealed that plant spacing had no significant effect in the measurement of plant height. Janick (1972) and Norman (1992) had reported that plants grow with a factor similar to competition among themselves, thus causing decreasing concentration of growth factors. The results obtained in this study is in agreement with the findings of Qayyum *et al.* (1986) who reported that plants should be grown at an optimum plant and row spacing in order to optimize their growth and development. Findings by Norman (1992) and Foidi *et al*. (2001) indicated that increasing plant density does not affect individual plants if the plant density is below the level at which competition occurs between plants. However, when plant density is too high and there is competition between plants then the yield of the crop decreases. It was therefore, postulated that for each crop, there is an acceptable plant density that is commensurate with marketing size and quality of the crop. Even though, competition may exist at high plant densities, plant spacing may be used provided the crop harvested falls within the marketable size range.

The number of leaves increased with a decrease in plant spacing. The closer the spacing (0.5 x 0.5 m and 0.5 x 0.75 m) produced more number of leaves of the fluted pumpkin. This is in agreement with the previous findings that an increase in plant populations has a reduction effect on the yield of grains produced by maize but inversely increases the number of leaves produced (Tetio-Kaho and Gardner, 1988). The increase in plant leaf area can be attributed to better assimilation of photosynthetate for active radiation and growth.

Average or medium spacing of 0.5 x 0.75 m produced the highest number of branches while the widest spacing of 0.75 x 1 m produced the highest leaf area. The results of this study also agrees with those of Badi *et al.* (2004) who reported that closer spacing produced a significant increase in leaf area and number of branches of *Thymus vulgaris*. Although, the wider spacing (0.5 x 0.75 m) gave a higher value for leaf count and number of branches compared to closer spacing, it still resulted in lower values per unit area. The plant grown under wider spacing (0.75 x 1 m) received more nutrients, light and moisture compared to plants of closer spacing, which was probably the cause of better performance in yield attributes. Similar findings was recorded in cabbage production as reported by Farooque and Mondal (1987); Rahman and Haque (1982); Hossain *et al.* (1983) and Nahar *et al.* (1996). Improper plant spacing may cause either too dense or too sparse population, resulting in the reduction of yield (Firoz *et al.,* 2009). The findings of this study are in agreement with Sadeghi *et al.* (2009), Aminifard *et al.* (2010), Mengistu and Yamoah (2010) and Gomez and Oberpaur (2007). They found that different plant variations affected significantly yield and growth factors. High spacing decreases yield with low plant density and low spacing decreases yield with plant competing with each other for light, water, nutrition and other growth requirement. On the other hand, widest spacing of 0.75 x 1.0 m produced the highest fresh and dry yield of fluted pumpkin. This could possibly imply that this spacing is adequate for the leaf formation and that the plant had adequate ground cover and had higher plant biomass which aid in the reduction of soil moisture and nutrient loss. Moisture content of any food is an index of its water activity and is used as a measure of stability and sturdy growth of plant (Uyoh *et al.,* 2013). The large biomass as observed in this study showed that the large leaf area of the leaves would increase the relative concentration of other food nutrients in the plants and therefore, improve shelf-life and preservation of plant produce (Aruah *et al*., 2012; Nwofia *et al.,* 2012).

CONCLUSION

A significant difference on the variation of plant spacing was observed. Also, the study revealed that the wider plant spacing of (0.75 x 1.0 m) could be adopted as the best for the production of bigger leaves; since the ultimate production in the farming of fluted pumpkin is the production of leaves.

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Table 1. Effect of Plant Spacing on Plant Height (cm) of Fluted Pumkin

Treatment	3WAS	6WAS	9WAS	12WAS
0.25 x 1 m	26.13	115. 9	259.2	308.4
0.5 x 0.5 m	22.47	107. 2	237.5	290.5
0.5 x 0.75 m	19.00	105. 0	226.0	274.5
0.5 x 0.1 m	17.67	105. 1	253.7	315.6
0.75 x 1 m	19.53	102. 1	247.9	303.3
Significance	0.05**	0.412^{NS}	0.545^{NS}	0.140^{NS}
S E M ±	1.054	4. 96	14.60	10.56
LSD	3.437	NS	NS	NS
CV%	9.6	5. 8	3.5	5.0

** = Significant at 5% level probability
NS = Non Significant

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Table 2. Effect of Plant Spacing on Stem Girth (cm) of Fluted Pumpkin

Treatment	3WAS	6WAS	9WAS	12WAS
0.25 x 1m	0. 980	1.177	1.3800	1.687
0.5 x 0.5m	1. 000	1.220	1.4000	1.680
0.5 x 0.75m	0. 960	1.167	1.3533	1.700
0.5 x 0.1m	0. 920	1.100	1.3200	1.640
0.75 x 1m	0. 913	1.167	1.3733	1.693
Significance	0. 429^{NS}	0.393 ^{NS}	0.129 ^{NS}	0.901 ^{NS}
S E M ±	0.0362	0.0397	0.01932	0.0471
LSD	NS	NS	NS	NS
CV%	1.3	3.0	0.4	2.5

NS = Non Significant

Table 3. Effect of Plant Spacing on the Number of Branches Produced by Fluted Pumpkin

Treatment	3WAS	6WAS	9WAS	12WAS
0.25 x 1 m	0.2000	0.73	5.80	6.67
0.5 x 0.5 m	0.2667	0.93	5.60	6.27
0.5 x 0.75 m	0.3333	2.00	6.13	6.80
0.5 x 0.1 m	0.2000	1.80	6.00	6.73
0.75 x 1 m	0.1000	1.20	6.20	6.78
Significance	0.05***	0.164^{NS}	0.822 ^{NS}	0.586 ^{NS}
S E M ±	0.0197	0.372	0.404	0.272
LSD	0.06431	NS	NS	NS
CV%	10.0	30.8	0.8	6.3

*** = Highly significant at 5% level probability
NS = Non significant

Table 4: Effects of Plant Spacing on Number of Leaves Produced by Fluted Pumpkin

Treatment	3WAS	6WAS	9WAS	12WAS
0.25 x 1 m	13.20	27.93	55.40	79.6
0.5 x 0.5 m	13.80	28.53	51.33	76.3
0.5 x 0.75 m	12.87	24.93	61.20	91.2
0.5 x 0.1 m	12.27	23.53	56.47	75.7
0.75 x 1 m	11.67	22.07	58.53	90.6
Significance	0. 040**	0.136^{NS}	0.062 ^{NS}	0.015 **
S E M ±	0.403	1.800	1.967	3.10
LSD	1.315	NS	NS	10.10
CV%	0.3	16.5	2.5	0.8

** = Significant at 5% level of probability

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Table 5. Effect of Plant Spacing on Leaf Area (cm^2) of Fluted Pumpkin

Treatment	3WAS	6WAS	9WAS	12WAS
0.25 x 1 m	35. 40	71.6	102.1	135.1
0.5 x 0.5 m	29. 18	69.5	100.8	126.8
0.5 x 0.75 m	23. 17	65.2	99.6	123.2
0.5 x 0.1 m	24. 02	70.0	113.4	137.4
0.75 x 1 m	26. 35	72.3	122.0	153.2
Significance	0.010***	0.09^{NS}	0.05*	0.03**
S E M ±	1.111	2.31	2.33	3.67
LSD	3.624	NS	7.60	11.98
CV%	2.9	4.3	0.5	1.1

*** = Highly significant 1% level, ** = Moderately Significant, * = Significant, NS = Non significant

Table 6: Effect of Biomass on Production of Fresh and Dry Weight of Fluted Pumpkin

Treatment	Fresh weight 12 WAS (Kg)	Dry weight 12 WAS (Kg)
0.25 x 1 m	0. 223	0.0727
0.5 x 0.5 m	0. 203	0.0720
0.5 x 0.75 m	0. 238	0.0780
0.5 x 0.1 m	0. 225	0.0783
0.75 x 1 m	0. 275	0.0830
Significance	0.432^{NS}	0.329^{NS}
S E M ±	0.0259	0.00389
LSD	NS	NS
CV%	7.2	3.9

NS = Non significant

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Effect of Rice Husk Biochar and Poultry Manure on the Growth and Yield of Okra (*Abelmoschus esculentus* L.) in Southern Guinea Savanna of Nigeria

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Abstract
This study on the effect of rice husk biochar and poultry manure on the growth and yield of okra, trial was conducted at the research farm Faculty of Agriculture, Nasarawa State University, Shabu-Lafia during 2017 rainy season; aimed at evaluating the effectiveness of using rice husk biochar and poultry manure on the growth and yield of okra. The treatment consisted of the following: Control; 2t/ha biochar; 4t/ha biochar; 6t/ha biochar; 8t/ha biochar; 12t/ha biochar; 2t/ha biochar + 10t/ha poultry manure; 4t/ha biochar + 10t/ha poultry manure; 6t/ha biochar + 10t/ha poultry manure; 8t/ha biochar + 10t/ha poultry manure; 12t/ha biochar + 10t/ha poultry manure; 10t/ha poultry manure alones. Laid in a randomized complete block design (RCBD) and replicated three times. Biochar and Poultry Manure were applied and left for one week before planting. Biochar single, poultry manure single and biochars combined with poultry manure had a significant ($p<0.05$) increased in the growth and yield parameters of okra. Application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the highest number of leaves (8.00, 10.00 and 17.67) at week 3, 5 and 7 after planting. Also, application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the tallest okra plants (18.47 and00 35.73cm) at week 3 and 7 after planting. Application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the highest number of okra fruits (36.77), fruit length (10.35cm), fruit diameter of 2.93cm, highest yield of okra fruits per plant (241.57g), and total weight of fruit yield of 6.44 t ha^{-1}. It can be concluded that mixture of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure could be the optimal rates of organic materials that can enhance a good growth and yield of okra in Southern |Guinea Savanna agroecological zone of Nigeria.
***Keywords**: Southern Guinea Savanna, Okra, Rice Husk Biochar, Soil Nutrition, Soil Amendment*

INTRODUCTION

Okra (*Abelmoschus esculentus* Moench) is an annual, herbaceous flowering plant in the Mallow family that originated from tropical and subtropical Africa and is natural to the West Africa (Aladele *et al*., 2008). Okra is mainly cultivated for its young immature fruits and consumed as a vegetable, raw, cooked or fried in countries like Sudan, Egypt and Nigeria; it is also important in other tropical areas including Asia, central and South America often used as ingredient for soups and sauces. The fruits can be conserved by drying; the roasted seed is considered as coffee substitute; the leaves, flower buds, flowers and calyces can be eaten greens (Ajari *et al*., 2003). In Nigeria, okra is grown in both wet and dry season but attract a larger profit in the dry season when the demand is often in excess with limited supplies (Ayeni *et al*., 2012). The fresh fruit is a good source of vitamins, minerals and plant protein (Eke *et al.*, 2008). Okra's flower can be very attractive and sometimes used in decorating the room (Schippers, 2000). In Nigeria the limiting factors in okra production and other vegetables among others include: low soil fertility, weed management, low yielding varieties and sub-optimal planting density (Iyagba *et al*., 2012). This assertion was also upheld by Fagwalawa and Yahaya (2016), who reported that okra production in Nigeria is currently faced with the challenges of low yield and they attributed the reasons of this low yield to poor soil fertility and deficiency in important mineral nutrients in the soil. Healthy soil contains a mixture of air,

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water, nutrients and organic matter in a right proportion which is the key for supporting healthy plants (Anderson *et al*., 2012). Therefore, every soil has the capacity of becoming a healthy soil, especially when the soil benefits from amendments. Therefore, Ndor et *al*., (2013) advocated the need for increased dependence on the use of organic materials such as farmyard manure, crop residues, poultry manure and biochar for soil amendment. Also, Lehmann and Joseph (2009), have earlier recommended the use of biochar as a good material for soil amendment. The addition of biochar as amendment materials to agricultural soils is receiving much attention due to the apparent benefits of biochar to soil quality and enhanced crop yields, as well as the potential to gain carbon credits by active carbon sequestration (Major, 2011). Biochar aid in soil nutrients improvement, cation exchange capacity in the soil, decrease soil acidity, improve soil structure, nutrient use efficiency, improve water-holding capacity and carbon sequestration (Zeelie,2012). At the other hand, poultry manure has been adjudged to be the most valuable of all manures produced by livestock (Omisore *et al*., 2009). Moreover, the nutrient contents of poultry manure are among the highest of all animal manures, and the use of it as soil amendment for agricultural crops will provide appreciable quantities of all the major plant nutrients. Poultry manure also improves biological activities, soil tilt and soil chemical properties (Ndor, and Ogara 2016). This study is aim at evaluating the effectiveness of using rice husk biochar and poultry manure on the growth and yield of okra in lafia.

MATERIALS AND METHODS

Experimental Site

The trial was established at the Research Farm Faculty of Agriculture Shabu Lafia, Nasarawa State University, Keffi, Shabu-Lafia Campus Nassarawa State in rainy season of 2017. The area lies between latitude 080 33'N, longitude 080 33'E and at an altitude of 181.53m above sea level. The study was made up of twelve treatments namely: T0 = Control; T1 = 2t/ha biochar; T2 = 4t/ha biochar; T3 = 6t/ha biochar; T4 = 8t/ha biochar; T5 = 12t/ha biochar; T6 = 2t/ha biochar + 10t PM T7 = 4t/ha biochar + 10t PM; T8 = 6t/ha biochar + 10t PM; T9 = 8t/ha biochar + 10t PM; T10 = 12t/ha biochar + 10t PM; T11 = 10t PM. The treatments were laid in a randomized complete block design (RCBD) and replicated three times.

Biochar Production

Rice husk was collected from rice mill for the production of biochar. An improvised kiln was produced which was an empty drum that was perforated but had a cover. The rice husk materials were poured inside the drum half full, then fired was ignited inside the drum and more sawdust materials were added and the drum lid was covered to encourage slow burning and the content in the drum was consistently stirred to enhance uniformity of burning. After 3-4hours the content of drum was poured out and the fire was quenched with water (by sprinkling water on the hot char) and dried in the sun for 2 days (Ndor et al., 2016).

Soil Sample Collection

Soil sample was initial collected at a depth of 0-15cm with soil auger before incorporating biochar and poultry manure. Soil samples collected were air-dried, and gently crushed, then passed through 2mm sieve to obtain a homogeneous particle size, after which both physical and chemical properties of these samples were determined.

Laboratory Analyses of Biochar and Poultry Manure

The biochar and poultry manure were collected separately and air-dried, then passed through 2 mm sieve mesh to obtain

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a homogeneous particle sizes, after which standard laboratory procedures as described by (Agbenin, 1995) were used for analysis of their chemical properties.

Cultural Practices for cultivation of okra

The land was cleared, ridges were manually constructed, biochar and poultry manure were incorporated into the plots at different rates and allowed to cure for 2 weeks before planting. The planting material (Okra seeds) local variety (Dansiriya) were bought from the Lafia market. Planting was carried out in July at a spacing of 50cm X 50cm. Three seeds were sown per hole and later thinned to two plants per stand at two weeks after sowing (WAS). Weeding was done manually using small hoes at four weeks after sowing and supplementary weeding was also carried out through hand pulling before the maturity of the crops. The okra plants were sprayed against beetles and caterpillars, by applying Cyperforce which has a systemic and contact action, at the rate of 0.5 litres per hectare (30 mls per 15 litres of water) four times during plant growth period, Spraying starts from 3 weeks after seedling emergence, and stopped before the plant starts fruiting.

Data Collection

Five plants were randomly sampled from each plot in the field and tagged for observation of growth and yield of okra. The growth data (plant height, number of leaves, and stem girth). Yield parameter (Days to 50%, number of fruit per plant, fresh fruit weight). The amended soil and crop data collected were subjected to analysis of variance using GENSTAT (2008 Ed), and where there was a significant difference; the means were separated using F-LSD at 5% probability level.

RESULTS AND DISCUSSION

The result of the soil physical analysis showed that the textural class in the experimental site before cropping was loamy sand, low in nitrogen, phosphorus, potassium, organic matter and also cation exchange capacity. The analysis however, indicated that the soil was acidic in nature with pH of 5.63; high in percent sand fraction (88.00) and also very high in percentage base saturation of 90.94% respectively. While, the biochar pH was almost neutral (7.34); total nitrogen was 0.59%; organic carbon 3.78 %; ashes (13.36 gkg^{-1}). Then organic matter was 6.50%; available phosphorus 3.01 $cmolkg^{-1}$; and low C.E.C of 5.18 $cmolkg^{-1}$ but high percentage base saturation of 96.52%. The poultry manure used was very high in both organic matter (35.12%) nitrogen (2.81%) and potassium (4.41%). While the pH was almost neutral (6.68).

Effect of Biochar and Poultry manure application on Growth parameters of Okra

Biochar single, poultry manure single and biochar combined with poultry manure had a significant ($p>0.05$) increased in the growth parameters (number of leaves, plant height and stem girth) of okra (Table 3). Application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the highest number of leaves (8.00, 10.00 and 17.67) at week 3, 5 and 7 after planting. This is statistically the same with application rate of 8 t ha^{-1} biochar + 10 t ha^{-1} poultry manure. The control plots produced the lowest number of okra leaves (3.97, 4.96 and 8.08) at week 3, 5 and 7 after planting. Also, application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the tallest okra plants (18.47 and00 35.73cm) at week 3 and 7 after planting. This is statistically the same with application rate of 8 t ha^{-1} biochar + 10 t ha^{-1} poultry manure and 6 t ha^{-1} biochar + 10 t ha^{-1} poultry manure at week 3 in Lafia. When okra was 5 weeks after planting, application of 8 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the tallest okra

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plants of 23.37cm in height. This is similar with application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure and 6 t ha^{-1} biochar + 10 t ha^{-1} poultry manure. Finally application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced okra plants with the biggest stem girth (2.14, 3.05 and 3.75cm) at week 3, 5 and 7 after planting compared with other rates. The control plots recorded the lowest stem girth of okra (1.09, 1.21 and 1.45cm) at week 3, 5 and 7 after planting respectively.

Effect of biochar & poultry manure application on Yield parameters of Okra

The result in table 4 showed that Biochar single, poultry manure single and biochar combined with poultry manure had a significant ($p<0.05$) increased on all yield parameters (Days to 50% flowering, number of fruit, fruit length, fruit diameter, fruits weight per plants and total yield (t/ha)) of okra. Application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the highest number of okra fruits (36.77), fruit length (10.35cm) and fruit diameter of 2.93cm which is the same with application of 8 t ha^{-1} biochar + 10 t ha^{-1} poultry manure. The control plots produced the lowest number of okra fruits (14.30), fruit length of (6.48cm) and fruit diameter (1.56cm). However, Biochar single, poultry manure single and biochar combined with poultry manure had no significant ($p<0.05$) increased on 50% flowering of okra. at Biochar single, poultry manure single and biochar combined with poultry manure had a significant ($p<0.05$) increased on fruit yield (fruit weight per plant and weight of okra tons per hectare) of okra. Application of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure produced the highest weight of okra fruits per plant (241.57g), and total weight of fruit yield of 6.44 t ha^{-1} The control plots produced the lowest weight of okra fruits t (88. 44g), and total weight 2.36 t ha^{-1}.

DISCUSSION

The vigorous performance in vegetative growth (number of leaves, plant height and stemgirth) of okra plant exhibited by application of higher rates of biochar mixed with poultry manure in this trial compare to biochar application alone; could be attributed to the fact that the soil in the study area consist of higher quantity of sandy particles, low clay content and deficient in some macronutrient (Table 1). When biochar and poultry manure were incorporated into the soil it reduces the sizes of the soil pores thereby increasing water holding capacity, increased Cation Exchange Capacity (CEC), and providing a medium for adsorption of minimal plant nutrients and improved conditions for soil micro-organisms (Sohi *et al.,* 2009). In addition, poultry manure that was used contain some mineral elements like N P and K (Table 2). These mineral elements especially nitrogen is responsible for growth of green plants. This explains why amending the soil with biochar and poultry manure brought about visible improvement in the growth performances of okra plant. This is in support of Odeleye *et al*., (2005), who reported a significant increase in all the growth parameter of okra plant when they used organic and inorganic fertilizer; which is an indication that okra plants were able to utilize the nutrients in the fertilizer material. It is also in consonance with the findings of Ojeniyi *et al*., (2007) who reported significant increase in plant height and yield with application of poultry manure. This is also in agreement with the results of Agbede and Adekiya (2013), who worked on the effect of wood ash, poultry manure and NPK fertilizer on soil and leaf nutrient composition, growth and yield of okra (*Abelmoschus esculentus*). The significant response of

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okra to yield and yield parameter (number of fruits, fruit length, fruit diameter and fresh fruit yield) recorded in the mixture of biochar and poultry man ure supplement in this study may be as a result of proper soil nutrient amendment which result to improvement in the soil fertility (Tables 2 and 3) and this is translated to better growth parameter of okra. This findings is in tandem with the earlier observation by Blay *et al.* (2001). Also, Moyin-Jesu and Ojeniyi (2000) reported the effect of animal manure and crop wastes on yield of okra (*Abelmoschus esculentus*) and found that the amendment of wood ash, ground cocoa husk, rice bran, spent grain and saw dust with goat, pig and poultry manures enhanced okra yield. The superiority exhibited by application of 12 t ha^{-1} biochar + 10 t ha^{-1} in both growth, yield and yield components of okra could be as a result of the poultry manure applied and the subsequent released of these nutrients within the soil because of reduction in leaching and nutrient immobilization, brought about as a result of the application of 12 t ha^{-1} biochar. Therefore, enough soil nutrients were available for uptake by okra plant and subsequently translating to luxuriant vegetative growth. This vegetative growth was translated to increase in yield per hectare.

CONCLUSION

From this study, it can be concluded that mixture of 12 t ha^{-1} biochar + 10 t ha^{-1} poultry manure could be the optimal rates of organic materials that can enhance a good growth and yield of okra in southern guinea savanna agroecological zone of Nigeria.

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Table 1: Analyzed results of the Soil, Biochar and Poultry manure to be use

Soil Properties	Lafia	Biochar	Poultry manure
Physical properties			
Sand%	88.0	ND	ND
Silt%	3.4	ND	ND
Clay %	8.6	ND	ND
Textural class	Loamy sand	ND	ND
Chemical properties			
pH in H_20	5.63	7.34	6.7
Ashes(gkg^{-1})	ND	13.56	ND
Organic carbon%	1.38	3.78	ND
Organic matter%	2.37	6.50	35.12
Total nitrogen%	0.21	0.59	2.81
P ($cmolkg^{-1}$)	3.01	3.01	0.78
Ca ($cmolkg^{-1}$)	3.48	0.31	1.13
Mg ($cmolkg^{-1}$)	2.63	1.34	0.51
K ($cmolkg^{-1}$)	0.25	3.01	4.41
Na ($cmolkg^{-1}$)	0.27	0.52	0.31
EA(cmolkg)	0.66	0.20	ND
CEC ($cmolkg^{-1}$)	7.29	5.18	ND
BS%	90.94	96.28	ND

ND = Not determined

Table 2. Effect of of biochar & poultry manure application on growth parameters of Okra

Treatments	Number of leaves			Plant height (cm)			Stem girth		
	3WAS	5WAS	7WAS	3WAS	5WAS	7WAS	3WAS	5WAS	7WAS
Control	3.97f	4.96g	8.08g	5.90g	8.25d	9.55h	1.08k	1.25j	1.45j
2t/ha biochar	4.67ef	5.67fg	9.00fg	7.30fg	9.50c	14.47g	1.13j	1.29i	1.58i
4t/ha biochar	5.00ef	6.33ef	9.33fg	8.37ef	11.17c	15.80g	1.23i	1.55h	1.85h
6t/ha biochar	5.33cde	6.67def	9.33fg	8.60ef	9.43c	16.20g	1.35h	1.67g	2.07g
8t/ha biochar	5.67cde	6.67def	10.33ef	10.67e	13.93bc	20.50f	1.41g	1.83f	2.27f
12t/ha biochar	5.67cde	7.00cdef	11.33e	10.00e	12.13c	22.57ef	1.47f	2.08e	2.38e
2t/ha biochar + 10 PM	6.67abc	7.67cde	13.33d	14.53cd	21.27a	25.47d	1.57de	2.32d	2.76d
4t/ha biochar + 10 PM	6.33bcd	8.33bc	14.00cd	15.53bc	19.67ab	28.73c	1.61d	2.83c	3.27c
6t/ha biochar + 10 PM	6.33bcd	8.33bc	15.33bc	16.27abc	20.00ab	31.40b	1.67c	2.97b	3.48b
8t/ha biochar + 10 PM	7.33ab	9.33ab	15.67b	17.50ab	23.37a	33.30ab	1.75b	2.97b	3.48b
12t/ha biochar + 10 PM	8.00a	10.00a	17.67a	18.47a	20.13a	35.73a	2.14a	3.05a	3.75a
10t/ha PM	6.00bcd	8.00cd	13.00d	13.13d	19.13ab	24.10de	1.57e	2.33d	2.77d
LSD	1.11	1.04	1.02	2.26	5.98	2.35	0.04	0.03	0.02
CV%	8.00	6.30	5.20	0.41	9.80	3.10	0.5	0.2	0.1

Means followed with the same letter are not statistically different at 5% level of significance

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Table 3. . Effect of of biochar & poultry manure application on Yield parameters of Okra

Treatments	fruit length	fruit diam.	No. of fruit.	Days to 50% Flowering	Fruit weight plant(g)	Yield kg/ha	Yield t/ha
Control	6.48i	1.56h	14.30i	53.33	88.44i	2358i	2.36g
2t/ha biochar	7.10h	1.68h	14.93hi	51.67	88.72i	2366i	2.37g
4t/ha biochar	7.28h	1.87g	17.00gh	50.00	97.60gh	2603gh	2.60fg
6t/ha biochar	7.59gh	1.90g	19.00g	56.00	105.87g	2821g	2.82f
8t/ha biochar	7.93g	2.03f	22.56f	47.67	122.80f	3275f	3.27e
12t/ha biochar	8.46f	2.22e	23.86f	50.33	127.94f	3412f	3.410e
2t/ha biochar + 10 PM	8.74de	2.44d	29.20de	51.00	172.32d	4595e	4.59cd
4t/ha biochar + 10 PM	9.06cd	2.60c	30.70cd	50.00	184.04c	4908cd	4.91c
6t/ha biochar + 10 PM	9.34bc	2.72bc	32.93bc	53.67	204.81b	5462b	5.46b
8t/ha biochar + 10 PM	9.70b	2.81ab	34.20b	53.67	218.88b	5837b	5.87b
12t/ha biochar + 10 PM	10.35a	2.93a	36.77a	53.67	241.57a	6442a	6.44a
10t/ha PM	8.48e	2.35d	28.20e	53.00	158.84e	4236e	4.27d
LSD	0.50	0.11	2.10	6.36	12.35	329.4	0.33
CV%	0.60	1.90	2.60	3.7	3.5	3.5	3.5

Means followed with the same letter are not statistically different at 5% level of significance

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Effect of Farmyard Manure and NPK 20-10-10 Fertilizer Rates on the Performance of Eggplant (*Solanum melongena* L.) at Samaru, Zaria

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Abstract
A field trial was conducted during the 2018 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria in the Northern Guinea Savannah Ecology to determine the ''effects of farmyard manure and NPK 20-10-10- fertilizer rates on the performance of eggplant (Solanum melongena L.) at Samaru, Zaria''. The trial was laid out in a randomized complete block design (RCBD) with five treatments; farmyard manure rates of 0, 2, 4, 6, 8 tons ha^{-1} combined with NPK 20-10-10 fertilizer rates of 0, 80, 100, 120 and 150 kg ha^{-1}, replicated four times to give a total of 20 plots. The crop established very well, all cultural practices were executed as required. Data was collected on plant height, number of leaves plant^{-1} and number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total yield ha^{-1}. All data collected was analyzed statistically using statistical analysis system software version 8. Means were compared using the least significant difference (LSD) at 5% level of probability. The effect of farmyard manure and NPK 20-10-10- fertilizer rates on the performance of eggplant were significant on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total shoot yield ha^{-1}. Application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer rate produced significantly higher growth and fresh total shoot yield of eggplant, while the control produced significantly lower similar traits.
Keywords: *Eggplant, farmyard manure, NPK 20-10-10 fertilizer rates, growth traits, fresh total shoot yield.*

INTRODUCTION

Eggplant (*Solanum melongena* L.) is an important vegetable crop in Nigeria. Species that are more popularly grown for their fruit and, in some cases also, the leaves and tender shoots exist. The crop has great potential for income generation as the fruits are consumed almost on daily basis by urban families. Manuring and choice of variety are among the most practical ways of raising yields of vegetables. Increasing urban populations have resulted in a growing tendency for farmyard and aquaculture enterprises to be located in urban and peri-urban areas in Nigeria. Apart from increasing farmyard population, aquaculture in Nigeria has recently expanded with the potential of producing about 2.5 million metric tons of fish annually, which suggests that huge amount of fish effluent will be discharged into the environment (Saidu *et al*, 2011).

Among improvement possibilities, the nutritional requirements play a major role. Nitrogen, Phosphorus and Potassium are major essential elements required for physiological mechanisms of plant growth (Cercioglu *et al.*, 2012). Nitrogen and phosphorus are usually the most limiting nutrients in many soils in Africa and are often simultaneously deficient (Ali *et al.*, 2013). Most soils in Sub-Sahara African are used for subsistence farming and are of low and declining fertility (Caliskan *et al.,* 2014). Continuous cropping with low or no fertilizer inputs, nutrient losses through harvest, soil erosion and leaching has led to decline in soil fertility (Cercioglu *et al.*, 2012; Chatterjee, 2015). In the East African region, P deficiency is of common occurrence in the highly populated highlands (Evans *et al.*, 2015). Organic inputs alone will not meet the nutritional needs of crops because they contain a comparatively less quantity of nutrients

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compared to inorganic fertilizers, the need to integrate the two forms in order to achieve better crop yields. The interaction between organic matter and inorganic fertilizers may lead to an increase in nutrients in soil depending on the nutrient and plant material in question (Eliakira and Yohana, 2013). Low use efficiencies of inorganic fertilizers coupled with their rising costs and the need for organically produced foods has directed the attention of farmers towards organic sources. Farmyard manure may increase soil fertility and thus the crop production potential possibly by changes in soils physical and chemical properties including nutrient bioavailability, soil structure, water holding capacity, cation exchange capacity, soil pH, microbial community and activities etc. (Hosseny and Ahmed, 2009). Soil pH is greatly influenced by addition of organic matter through different organic amendments and change in pH varies with the nature of organic matter (Michael et *al.*, 2012)

Some organic materials can increase crop yields due to improved soil through nutrient release during decomposition and mineralization. They may also improve soil physical properties such as moisture retention, bulk density and aeration (Mohammed, 2007). In addition, they generally have greater residual effect on subsequent crops than inorganic nutrient sources due to slow release of their nutrients over time (Okur *et al.*, 2008). They can also result in complexion of aluminum and iron with organic compounds from decomposition resulting in greater availability of phosphorus and reduction of aluminum toxicity. Organic fertilization is also important for providing plant with their nutritional requirements without having an undesirable impact on the environment (Niyibigira, 2011). Addition of different sources of farmyard manure increases the plant growth characteristics namely plant height, number of leaves and shoots per plant, fresh and dry weight of shoots of plants (Ouda and Mahadeen, 2008). It has been shown that increase in garden egg yield produced by organic-mineral compounds was greater than those produced by mineral fertilizer applied at the same rate (Quresh *et al.*, 2014). Organic amendments especially when applied in high rates can increase the availability and use efficiency of phosphorus by plants (Siti and Farazehty, 2013). This has been observed to be so for farm yard manure (Siti and Farazehty, 2013). It has also been demonstrated for green leaf biomass of *Tithonia diversifolia* (Subash *et al.*, 2012). Organic materials besides enhancing P availability and even supplying some P, their major benefits are likely to be the provision of other nutrients, especially N. This is because of their high tissue concentration of N compared to other nutrients (Subash *et al.*, 2012).

Farmers in Nigeria especially Zaria, have not adopted a particular rate of farmyard manure and NPK 20-10-10 fertilizer application; some apply higher rates, while others apply lower rates. This variation in the rates of farmyard manure and NPK 20-10-10 fertilizer application has not resulted into yield increases in eggplant. Therefore, optimum rate of farmyard manure and NPK 20-10-10 fertilizer application or any sources of nutrition in eggplant would increase the growth and yield. The objective of the study is to determine the optimum rate of farmyard manure and NPK 20-10-10 fertilizer application that optimizes its use as sources of nutrient for garden egg growth and total shoot yield in Samaru, Zaria.

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MATERIALS AND METHODS

Site Location

The experiment was conducted at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria located in the northern guinea savanna zone, situated on Latitude $11^0 11$`N and Longitude $07^0 38$`E at an altitude of 686m above sea level. The area has a tropical wet and dry climate with mean annual temperature and rainfall of 29^0C and 900mm-1000mm, respectively (Field Survey, 2018).

Experimental Design and Treatments

The experimental design used was randomized complete block design (RCBD), consisting of 5 treatments combination of farmyard manure rates of 0, 2, 4, 6 and 8 tons and NPK 20-10-10 fertilizer rates of 0, 80, 100, 120 and 150 kg ha^{-1}, replicated four times.

Sowing and Crop Management

Seeds of eggplant (*Solanum melongena* L.*)* were sown in the field at the rate of three seeds hole^{-1} which will later be thinned to two seedlings hole^{-1}.

Data Collection

Data was collected in the field on plant height (cm), number of leaves plant^{-1}, number of branches plant^{-1}, leaf area (cm^2) plant^{-1}, fresh shoot yield plant^{-1} (gm), fresh shoot yield ha^{-1} (kg).

Statistical Analysis

All data collected was analyzed statistically using statistical analysis system (SAS) software version 8. Means were separated using the least significant difference (LSD) at 5% level of probability (Rangaswamy, 2010).

RESULTS

Physical and Chemical Analysis of soil used for the Experiment

Table 1 shows the physical and chemical analysis of the soil used for the trial during the 2018 cropping season. The soil contains a higher proportion of sand (48%), silt (62 %), low clay (7.80 %) and low organic carbon (1.26%). The chemical analysis also show that pH in water was (6.60), the total nitrogen was low (0.145 %), low available phosphorus (32.35ppm), low available potassium (0.35 mg kg^{-1}), low available calcium (3.78 mg kg^{-1}), low available sodium (0.79 mg kg^{-1}), low available magnesium (1.44 mg kg^{-1}) and low cation exchange capacity (7.23 mg kg^{-1}).

Plant height (cm)

Table 2 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant in 2018 cropping season on plant height. At 4 and 8WAS, there was no significant difference (P>0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates.

Number of leaves plant^{-1}

Table 2 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant in 2018 cropping season on number of leaves plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates on number of leaves plant^{-1}, however, at 8 WAS, there was a significant difference (P<0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates. Farmyard manure at 8 tons ha^{-1} and NPK 20-10-10 fertilizer at 150 kg ha^{-1} significantly produced higher mean values over the rest of the treatments.

Number of branches plant^{-1}

Table 2 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates

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on the performance of eggplant in 2018 cropping season on number of branches plant^{-1}. At 4 and 8WAS, there was a significant difference (P<0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates. Farmyard manure at 8 tons ha^{-1} and NPK 20-10-10 fertilizer rate at 150 kg ha^{-1} significantly produced higher mean values over the rest of the treatments.

Leaf area (cm^2) plant^{-1}

Table 2 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant in 2018 cropping season on leaf area plant^{-1}. At 4 and 8WAS, there was no significant difference (P>0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates.

Fresh Total Shoot Yield (gm) Plant^{-1}

Table 3 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant in 2018 cropping season on fresh total shoot yield plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to fertilizer rates, however, at 8 WAS, there was a significant difference (P<0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates. Farmyard manure at 8 tons ha^{-1} and NPK 20-10-10 fertilizer rates at 150 kg ha^{-1} significantly produced higher mean values over the rest of the treatments.

Fresh Total Shoot Yield (kg) ha^{-1}

Table 3 show the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant in 2018 cropping season on fresh total shoot yield ha^{-1}. At 4 and 8WAS, there was a significant difference (P<0.05) among the treatment means due to farmyard manure and NPK 20-10-10 fertilizer rates. Farmyard manure at 8 tons ha^{-1} and NPK 20-10-10 fertilizer rates at 150 kg ha^{-1} significantly produced higher mean values over the rest of the treatments.

DISCUSSION

The results obtained in this investigation showed that farmyard manure and NPK 20-10-10 fertilizer rates used improved the performance of eggplant plants compared to the control where no manure or fertilizer was applied. This observation corroborates the previous research of Ouda and Mahadeen (2008) who observed that the use of farmyard manure has been recommended for long term cropping in the tropics as slow mineralization of these manures promotes crop yield for a long period of time. The most satisfactory method of increasing crop yields is by judicious use of farmyard manure in combination with little portions of the inorganic sources for nutrient use efficiency (Ouda and Mahadeen, 2008).

There have been several reports on the use farmyard manure for growth and development of crops. Ali *et al.* (2013) reported that farmyard manure activate many species of living organisms which release phyto hormones and may stimulate plant growth and absorption of nutrients. Ouda and Mahadeen (2008) reported that such organisms need nitrogen for multiplication. Similar results were also reported by Michael *et al*. (2012), that animal manure applications increased crop yield. The study revealed that farmyard manure at 8 tons in combination with NPK 20-10-10 fertilizer at 150 kg ha^{-1} produced the highest yield of eggplant plants by increasing the plant height, number of leaves, number of branches, leaf area and yield plant^{-1} and ha^{-1}. This agrees with the report of Caliskan *et al.* (2014) who reported that the application of N as a major component of farmyard manure has been reported to improve the yield of plants. Evans *et al.* (2015) also reported that poultry manure is cheap and effective as a good source of N for sustainable crop

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production. Chatterjee (2015) reported that cucumber plants receiving poultry litter as nutrient source surpassed that fertilized with cow dung in terms of number of leaves plant^{-1}, vine length, foliar spread, leaf area, fruit weight, fruit length, number of fruit plant^{-1}, fruit diameter, seed weight and number of seeds fruit^{-1}.

Pig manure also gave a higher yield. This agrees with the report of Siti and Farahzety (2013); Eliakira and Yohana (2013), who reported that applications of pig manure at 4 and 8 tons ha^{-1} significantly increased growth and pod yield of okra and was more effective than goat manure. NPK 20-10-10 fertilizer rates produced higher fresh shoot yield of eggplant than the control. This agrees with the report of Cercioglu *et al.* (2012) who stated that cattle manure is a potential source of nutrients and also has a potential benefit to soil amelioration especially for communal farmers who cannot afford fertilizers. Zahradnik and Petrikora (2007) stated that the application of goat manure as source of N, observed an increase in soil N and P, root growth, fresh and dry matter yield of eggplant. Evans *et al.* (2015) stated that the application of sheep manure increased fresh weight, dry weight, bulb diameter, bulb height and plant height by 96.05, 104.48, 95.86, 37.48, 26.93 and 17.41% compared to the control, respectively.

Conclusion

From the results, it was observed that the effects of farmyard manure and NPK 20-10-10 fertilizer rates on the performance of eggplant were significant on plant height, number of leaves plant^{-1} and number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total yield ha^{-1}. Application of 8 tons ha^{-1} of farmyard manure and 150 kg ha^{-1} of NPK 20-10-10 fertilizer rates produced significantly higher growth and fresh shoot yield, while the control produced significantly lower similar traits. Farmers, who are into eggplant production in Samaru-Zaria, are advised to use 8 tons ha^{-1} of farmyard manure and NPK 20-10-10 fertilizer rates of 150 kg ha^{-1} because it produced significantly higher growth and fresh total shoot yield than the other treatments.

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Table 1: Physical and Chemical Analysis of the Soil from the Experimental Site during the 2018 Cropping Season.

Composition	Value
% Clay	7.80
% Silt	62
% Sand	48
Textural class	Loam
pH ratio	1: 2.40
H_20	6.60
0.01M $CaCl_2$	6.22
% OC	1.26
% TN	0.145
AP (ppm)	32.35
Exchangeable Bases (Cmol kg^{-1})	
Ca	3.78
Mg	1.44
K	0.35
Na	0.79
CEC	7.23

Source: Department of Soil Science, Faculty of Agriculture, ABU Zaria

Table 2: Effects of Farmyard Manure and NPK 20-10-10 fertilizer Rates on Growth Parameters of eggplant at Samaru, Zaria.

	Plant height (cm)		Number of leaves plant^{-1}		Number of branches plant^{-1}		Leaf area (cm^2) plant^{-1}	
Treatments	4WAS	8WAS	4WAS	8WAS	4WAS	8WAS	4WAS	8WAS
Farmyard Manure Rates (tons ha^{-1}) and NPK 20 -10 -10 Fertilizer Rates (kg ha^{-1})								
0 + 0	23.45	35.82	2.11	5.65	3.65	4.33	33.45	42.11
2 + 80	23.63	36.34	2.14	7.28	4.28	5.11	33.68	43.26
4 + 100	23.77	36.62	2.21	8.47	5.47	6.23	34.22	44.27
6 + 120	23.80	37.19	2.34	10.11	6.11	6.58	35.65	44.35
8 + 150	23.88	37.88	2.42	11.33	7.33	7.28	36.44	45.28
LSD	1.88	2.90	1.11	1.43	1.25	1.34	2.11	2.88

Table 3: Effects of Farmyard Manure and NPK 20-10-10 fertilizer Rates on Fresh Total Shoot Yield of eggplant at Samaru, Zaria.

	Fresh Total Shoot Yield (gm) Plant^{-1}		Fresh Total Shoot Yield (kg) ha^{-1}	
Treatments	4WAS	8WAS	4WAS	8WAS
Farmyard Manure Rates (tons ha^{-1}) and NPK 20-10-10- fertilizer Rates (kg ha^{-1})				
0 + 0	30.12	45.33	150.10	162.43
2 + 80	31.20	47.58	172.23	183.15
4 + 100	32.34	49.78	181.32	198.73
6 + 120	32.46	52.26	200.20	261.22
8 + 150	33.20	54.36	225.10	274.55
LSD	2.24	2.92	27.32	33.47

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Growth and Yield of Two Edible Mushrooms on Cassia Sawdust at Different Composting Intervals

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Abstract
Mushrooms are known for unique taste, promotion of good health and vitality. This study was to determine the optimal composting time to improve growth and yield of mushroom on cassia sawdust as mushroom substrate. The experiment was a 2 x 3 factorial combination in complete randomized design (CRD). Treatments comprised of two varieties of mushrooms (Pleurotus ostreatus and Pleurotus pulmonarius) and three composting intervals (4, 8 and 12 weeks). Width of pileus, length of stipe, fruit weight and number of fruits, biological efficiency (BE), production efficiency (PE), mycelia extension, number of days to primordial initiation and full mycelia colonization were observed and subjected to analysis of variance. Significant means were separated using Duncan's multiple range tests. Results revealed mushroom grown on cassia substrate composted for 12 weeks produced the longest mycelia extension (12.12 cm), BE (76.10%), PE (37.65%), shortest number of days for full mycelia colonization and primordial initiation (21.67 and 24.67 days respectively) and heaviest fruit weight. Both mushrooms had comparable average mycelia extension per day, BE and PE. P. pulmonarius on cassia composted for 12 weeks was better in terms of mycelia extension (12.13 cm), average fruit weight and length of stipe (6.53 cm). P. ostreatus produced the highest number of fruits (11.11) and fruit weight (51.04 g), shorter number of days to full mycelia colonization and primordial initiation (22.89 and 26.56 days respectively). Composting cassia for 12 weeks improved growth and yield of mushroom than 4 and 8 weeks. Morever, P. ostreatus performed better than P. pulmonarius.
Key words: *Composting intervals, biological efficiency, production efficiency, Pleurotus ostreatus, Pleurotus pulmonarius*

INTRODUCTION

Mushrooms have been regarded as gourmet cuisine across the globe since antiquity for their unique taste and subtle flavor. Recently, it has been discovered that many mushroom species are miniature pharmaceutical factories, producing hundreds of novel constituents with miraculous biological properties. They have a long history of use in Oriental medicine, but their legendary effects in promotion of good health and vitality are being supported by contemporary studies only (Patel and Goyal, 2012). Over 2,500 different mushrooms grow in the wild around the world and their nutritional potential has long been overshadowed by the well known cultivated mushrooms such as *Lentinus edodes*, *Pleurotus species* and *Agaricus bisporus*. In Uganda, wild mushrooms are mainly collected during the rainy season and valued as a traditionally nutritious food by the rural poor (Nakalembe *et al*., 2015). They are recognized as nutritionally functional food and a source of physiologically beneficial and nontoxic medicines (Biswas *et al*., 2018).

The cultivation of edible mushrooms in agro-industrial residues has been shown as an alternative to better utilization of the organic matter. Usually at the end of cycle, the biomass obtained can be used as food due to its high nutritional value (Da Fonseca *et al*., 2015). Mushroom has been produced *in vitro* in several agricultural and horticultural wastes such as sawdust, banana pseudostems, banana leaves and cassava peel as well as agro-industrial substrates such as castor plant peel, rice straw, sugarcane bagasse, cotton waste, soybean straw, corn cob, elephant grass, oat, rye grass, sunflower seed, water hyacinth, tillage and privet (Aguiar *et al*., 2010; Reis *et al*., 2010; Otunla and Idowu,

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2012; Idowu and Otunla, 2014; Idowu *et al*., 2015).

Pleurotus is an important mushroom genus known for its high content of proteins, carbohydrates, minerals (calcium, phosphorus and iron) and vitamins (thiamine, riboflavin and niacin), as well as low fat content. These mushrooms have the ability to colonize and degrade a wide variety of lignocellulosic wastes with relatively short cycle (Menolli Junior *et al*., 2010; Omarini *et al*., 2010). This research study was carried out to determine the optimal composting time to improve the growth and yield of *Pleurotus ostreatus* and *P. pulmonarius* on cassia sawdust as a mushroom substrate.

MATERIALS AND METHODS

The study was conducted at the mycology laboratory of the National Horticultural Research Institute (NIHORT), Ibadan, Oyo State, South-West Nigeria.

Source of substrate

The substrate, cassia (*Senna siamea*) tree, used was obtained within the premises of the National Horticultural Research Institute (NIHORT), Ibadan and identified by the floriculture unit of NIHORT. This substrate (stem with the bark), was milled at Sanngo sawmill, Ibadan after harvesting and stored in the mushroom laboratory, NIHORT, until when needed.

Source of spawn

The spawns of the two mushrooms (*Pleurotus ostreatus* and *Pleurotus pulmonarius*) were obtained from the mushroom unit, NIHORT, Ibadan. The generated inocula were from the mushroom sporophore obtained at Songhai farm in Porto Novo in Benin Republic and maintained on Potato Dextrose Agar (PDA) for regular sub-culturing according to the method described by Quimio *et al.* (1990).

Research Design

The experiment was a 2 x 3 factorial combination in complete randomized design (CRD) in three replicates. Treatments comprised of two varieties of mushrooms (*P. ostreatus* and *P. pulmonarius*) and three composting intervals (4, 8 and 12 weeks).

Mycelial growth on sawdusts

Sawdust substrate from *Senna siamea* was moistened until the moisture content was about 65%. It was filled into test tubes of the size 2.3 cm x 15 cm in three replicates, sealed with cotton plug and aluminium foil. In an autoclave, these test tubes were sterilized at 121^{o}C for 15 min. They were allowed to cool down to room temperature (30±2^{o}C) after sterilization, aseptically inoculated with freshly prepared spawn and incubated at room temperature for 2 weeks. These procedures were repeated on the treatments when the sawdust was 4, 8 and 12 weeks old at storage.

Production of fruiting bodies of *P. ostreatus* and *P. pulmonarius*

Cassia sawdust was packed into 300 g samples after moistening with water to about 65% in transparent polyethylene bags of size 25 x 15 cm. The neck of the bag was prepared using heat resistant PVC (Poly Vinyl Chloride) tube, plugged with cotton wool, replicated 3 times and sterilized in an autoclave at 121^{o}C for 15 min**.** The sterilized substrates bags were inoculated with 30 g of the mushroom spawn separately after cooling to room temperature in an inoculating hood and transferred to the vegetative room at 30±2^{o}C. The biological efficiency of the substrates was calculated according to the method of Khanna and Garcha (1982). These procedures were carried out on each of the mushroom under investigation at the different composting intervals of 4, 8 and 12 weeks.

Data Collection and Analysis

Daily growth and development of the mushrooms were monitored. Mycelia extension, days to full mycelia colonization and primordial initiation, number of fruits, fruit weight, average fruit weight, width of pileus, length of stipe, biological and production efficiencies were obtained and analyzed by ANOVA

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while significant means were separated using Duncan's multiple range test.

RESULTS

Mycelia running and pin-head formation

The substrate supported the mycelia growth of both mushrooms. However, it was visually observed that the mycelia density of *P. ostreatus* was more than that of *P. pulmonarius.* The longest mycelia extension (12.12 cm) and average extension per day (0.64 cm) were recorded at 12WCI while the least extension per day (0.48 cm) was observed at 4WCI (Table 1). Similarly, the required time for mycelia running and pin-head formation (primordial initiation) were shortest at 12WCI (21.67 and 24.67 days respectively) as the longest number of days (25.17 days) for full mycelia running and primordial initiation (29.67 days) were recorded at 4WCI.

The mycelia growth (9.58 cm) of *P. pulmonarius* was longer than that of *P. ostreatus* (8.50 cm) (Table 3). However, the average extension per day was not significantly different from each other (0.56 cm). The number of days to full mycelia running and primordial initiation were short with *P. ostreatus* (22.89 and 26.56 days respectively) while *P. pulmonarius* recorded a relatively long full mycelia running (24.11 days) and primordial initiation (28.00 days).

Yield

Highest number of fruits (11.83) was observed at 12WCI (Table 2), which was not significantly different from what was recorded at 8WCI (11.17). The least (2.83) was recorded at 4WCI. Also, the highest fruit weight (79.90 g) was recorded at 12WCI which was significantly different from 52.79 g observed at 8WCI while the least (18.68 g) was recorded at 4WCI. The heaviest average fruit weight (6.88 g) was observed at 12WCI which was comparable to what was recorded at 4WCI (6.60 g). The least (6.08 g) was recorded at 8WCI. The largest width of pileus (5.87 cm) was recorded at 8WCI which was significantly different from the comparable results obtained at 12WCI and 4WCI (5.60 cm and 5.47 cm respectively). At 8WCI, the longest length of stipe (5.40 cm) was observed which was not significantly different from what was recorded at 12WCI (5.33 cm). The least was observed at 4WCI (4.65 cm). Both BE and PE followed the same trend (12WCI> 8WCI>4WCI).

As shown in Table 3, *P. pulmonarius* recorded a higher average fruit weight (7.91 g) than *P. ostreatus* (5.19 g). The width of pileus recorded on *P. pulmonarius* (6.14 cm) was larger than that of *P. ostreatus* (5.14 cm). Similarly, the length of stipe observed with *P. pulmonarius* was significantly different from that of *P. ostreatus* (5.94 cm and 4.31 cm respectively). However, *P. ostreatus*recorded higher number of fruits and fruit weight than *P. pulmonarius* (Figure 1).

DISCUSSION

Mycelia growth of both mushrooms on cassia sawdust substrate was in support of various previous research studies (Otunla and Idowu, 2012; Apetorgbor *et al*., 2013; Idowu *et al*., 2015). This established the presence of nutrients in the cassia sawdust for the mushroom. However, as decomposition progressed, it is expected that many of the macromolecular components in the cassia substrate would be broken down into micromolecules, releasing more nutrients. This is made possible because mushrooms have many hydrolyzing and oxidizing enzymes. They have the ability to degrade lignin and cellulose as they are wood consuming fungi (Emuh, 2009; Olatunji and Horsfall, 2014; Ohiri, 2018). Variations in the mycelia cover or extension at each composting interval may be due to the differences in the nutrient availability. The longest mycelia extension and average extension per day at 12WCI could be attributed to long period of composting as

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it allows the release of more nutrients (Girmay *et al*., 2016). Furthermore, mushroom mycelial growth and primordial development depends on the properties of lignocellulosic materials, particularly on the C/N ratio (Narain *et al*., 2009; Dias Nunes *et al*., 2012).

Mycelia of *P. pulmonarius* grew faster than that of *P. ostreatus* which agreed with the work of Girmay *et al*. (2016) that observed that the growth of *P. ostreatus* mycelia on wheat straw and sawdust was relatively slow compared with cotton seed and paper waste substrates. Mycelia colonization was completed between 22.89-24.11 days of incubation and primordial initiation was observed between 26.56-28.00 days. This agreed with the work of Sharma *et al*. (2013) that reported 22.40-26.00 days and 26.40-31.60 days for mycelia colonization and primordial initiation respectively. However, Ahmed (1998) reported spawn running of *P. ostreatus* to be completed within 17–20 days and pin-head formation between 23 and 27 days from spawning on different substrates.

The number of fruits and total fruit weight of *P. ostreatus* was more than that of *P. pulmonarius*. As observed in this study, the visual mycelial density of *P. ostreatus* was higher than that of *P. pulmonarius*. This is directly proportional to the yield as stated by Thomas *et al.* (1998).

CONCLUSION AND RECOMMENDATION

Pleurotus ostreatus proved to be better in terms of shorter number of days to full mycelia colonization and primordial initiation, number of fruits and total fruit weight. Therefore, of the two mushroom varieties (*Pleurotus ostreatus* and *Pleurotus pulmonarius*) in this investigation, *Pleurotus ostreatus* is better on cassia sawdust substrate and 12 weeks was the best composting interval.

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Table 1: The growth parameters of *Pleurotus ostreatus* and *P. pulmonarius* cultivated on cassia sawdust

Weeks of composting interval (WCI	Mycelial extension (cm)	Average extension per day (cm)	Full Mycelial colonization (Days)	Primordia initiation (Days)	Biological Efficiency (%)
4	9.32	0.48	25.17	29.67	17.79
8	5.69	0.56	23.67	27.50	50.28
12	12.12	0.64	21.67	24.67	76.10
LSD	0.71	0.01	1.33	1.11	1.38
INTERACTION					
Ost/ 4WCI	7.50	0.48	29.33	24.67	22.53
Ost/ 8WCI	11.13	0.52	30.00	25.67	13.04
Ost/ 12WCI	5.88	0.56	27.00	23.67	53.77
Pul/ 4WCI	5.50	0.56	28.00	23.67	46.79
Pul/ 8WCI	12.11	0.68	23.33	20.33	69.53
Pul/ 12WCI	12.13	0.59	26.00	23.00	82.66
LSD	1.01	0.02	1.57	1.88	1.95

Ost: *Pleurotus ostreatus*, Pul: *P. pulmonarius*, WCI: Weeks of composting interval

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Table 2: The yield parameters of *Pleurotus ostreatus* and *P. pulmonarius* cultivated on cassia sawdust

Weeks of composting interval (WCI)	Number of fruits	Fruit weight (g)	Average fruit weight (g)	Width of pileus (cm)	Length of stipe (cm)	Production Efficiency (%)
4	2.83	18.68	6.60	5.47	4.65	7.15
8	11.17	52.79	6.08	5.87	5.40	23.17
12	11.83	79.90	6.88	5.60	5.33	37.65
LSD	1.29	1.44	0.67	0.24	0.21	1.78
INTERACTION						
Ost/ 4WCI	3.67	23.66	6.51	4.53	4.13	9.40
Ost/ 8WCI	2.00	13.70	6.85	6.40	5.17	4.89
Ost/ 12WCI	16.67	56.44	3.42	5.13	4.67	25.20
Pul/ 4WCI	5.67	49.13	8.74	6.60	6.13	21.14
Pul/ 8WCI	13.00	73.00	5.63	5.77	4.13	34.23
Pul/ 12WCI	10.67	86.79	8.14	5.43	6.53	41.08
LSD	1.82	2.04	0.95	0.34	0.29	2.51

Ost: *Pleurotus ostreatus*, Pul: *P. pulmonarius*, WCI: Weeks of composting interval

Table 3: The growth and yield parameters of *Pleurotus ostreatus* and *P. pulmonarius* cultivated on cassia sawdust

Parameters	Mushrooms		
	Pleurotus ostreatus	*Pleurotus pulmonarius*	LSD
Mycelial extension (cm)	8.50	9.58	0.58
Average extension per day (cm)	0.56	0.56	0.01
Full Mycelial colonization (Days)	22.89	24.11	1.08
Primordia initiation (Days)	26.56	28.00	0.91
Biological Efficiency (%)	48.61	47.50	1.13
Production Efficiency (%)	22.94	22.37	1.45
Number of fruits	11.11	6.11	1.06
Average fruit weight (g)	5.19	7.91	0.55
Width of pileus (cm)	5.14	6.14	0.20
Length of stipe (cm)	4.31	5.94	0.17

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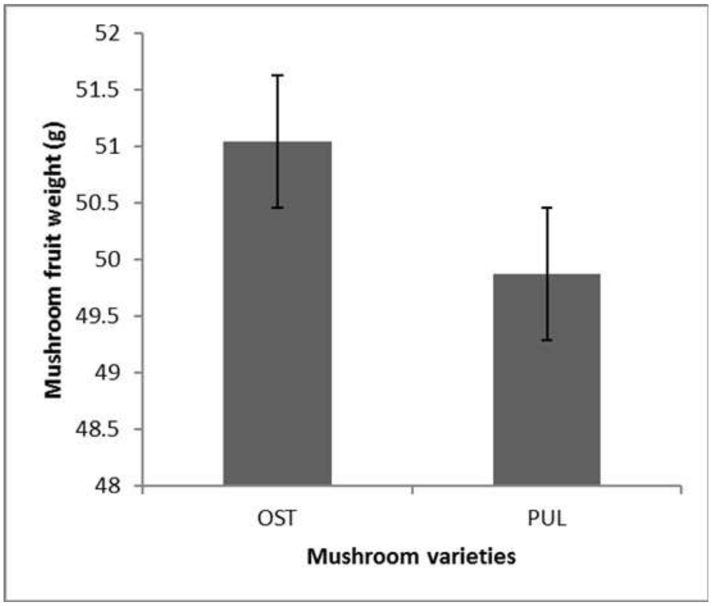

OST: *Pleurotus ostreatus*　　　　PUL: *P. pulmonarius*

Figure 1: The mushroom fruit weight of *Pleurotusostreatus*and*P. pulmonarius* on cassia substrate

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Antiviral Potential of Baking Soda in the Management of Amaranthus Mosaic Virus

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Abstract
Amaranth is an important vegetable containing very high amount of micronutrients and vitamins. Production of amaranth is limited by pests and diseases especially viruses and their insect vectors, thus reducing the market and nutritional qualities of the vegetable. The experiment was conducted at the experimental field of the Institute of Agricultural Research and Training, Ibadan, Nigeria to study the antiviral potential of baking soda in the management of Amaranthus mosaic virus. The study involved the spraying of A. cruentus at 2 and 4 weeks after planting (WAP) with the following treatments; baking soda (BS) alone; cypermethrin alone; mixture of BS and half dose of cypermethrin, and untreated control. Incidence and severity of Amaranthus mosaic virus (AMV) were determined as well as the weed species dominating the treated plots. Results revealed that the combination of BS and cypermethrin produced the highest plant height with values of 17.5 cm and 66 cm at 3 and 5 WAP respectively. Leaves were severely damaged in the untreated control plants compared with the treated plants. Reduced virus incidence were obtained when BS or its mixture with cypermethrin were used. A total number of seven weed species dominated the plots. Baking soda or their combinations with synthetic pesticides efficiently reduced the incidence and severity of AMV in A. cruentus.
***Key words**: Amaranth, Disease, Incidence, Pesticide, Amaranthus mosaic virus*

INTRODUCTION

Amaranths are leafy vegetables which belong to the family Amaranthaceae. Amaranths are nutrient rich foods which improve food security and reduce malnutrition in African communities that solely depend on subsistence agriculture (Emire,and Arega, 2012). Insects pose a serious threat to amaranth growers (Palou *et al*., 2001) and some of these insects transmit viruses to cultivated crops. Pesticides are used for the control of insects but they are toxic to humans and the environment. Therefore, there are needs for alternatives which are Generally Recognized as Safe (GRAS). Studies have shown the effectiveness of salts in the control of various pathogens of many crops (Grubben, 2004; El-Mougy and Abdel-Kader, 2009). The benefits of baking soda (sodium bicarbonate; $NaHCO_3$) for the management of several plant diseases have been reported (Kuepper *et al*., 2001). Sodium bicarbonate is one of the registered biopesticides by Environmental Protection Agency in USA.

MATERIALS AND METHODS

The experiment was conducted at the experimental field of the Institute of Agricultural Research and Training, Ibadan, Nigeria. It consisted of four treatments; i) plots sprayed with 7.5 ml/L of cypermethrin (synthetic pesticide), ii) plots sprayed with 15 g of baking soda (BS) suspended in 1.0 L of tap water, iii) plots sprayed with 3.75 ml of cypermethrin and 7.5 g of BS; both suspended in 1.0 L of tap water and iv) unsprayed plot (control) replicated three times and laid out in Randomized Complete Block Design. Seeds of *Amaranthus cruentus* (NHAc3) were obtained from the National Horticultural Research Institute, Ibadan, Nigeria. Seeds were sowed by drilling on 1 m x 1m bed. After germination, the seedlings were thinned to a spacing of 20 cm x 20 cm and four plants were tagged per bed. First spraying was carried out 2 weeks after planting (WAP) and data collected 1 week after spraying which is equivalent to 3 WAP. The second spraying was carried out 4 WAP and data collected 1 week after spraying which is equivalent to 5 WAP.

Plant height was determined using a meter rule to measure the height of the plants from the base to the apex, Number of leaves was determined by counting the total number of leaves on each plant, Virus incidence was determined by counting the number of virus infected plants and expressing it as a percentage of the total number of plants on each plot. The determination of leaf damage and virus severity was on a scale of 1 to 5 with 1 representing absence of leaf damage/virus infection and 5 representing very severe leaf damage/very high virus infections.

Weed species that emerged from the plots were counted and identified; this is to study the effect the various treatments have on weed species diversity and abundance. The weeds were identified to species level using Akobundu (1987).

Data obtained were subjected to statistical analysis of variance using Statistical Package for Social Sciences (SPSS). New Duncan multiple range test was used to separate means at $P \leq 0.05$. Pearson correlation was used to determine the relationship between measured parameters and disease traits.

RESULTS

Effect of baking soda and cypermethrin on agronomic parameters (plant height and number of leaves) of *Amaranthus cruentus*

The results obtained at 3 WAP revealed that spraying at 2 WAP with mixture of cypermethrin and baking soda (BS) had significantly highest plant height (17.55 cm) while there was no significant difference in the heights of plants sprayed with cypermethrin only (15.33 cm) and baking soda only (11.53 cm). The control had the least plant height of 10.07 cm. The treatments did not have any significant effect on the number of leaves of *A. cruentus* at 3 WAP, however, mixture of cypermethrin and baking soda had the highest (9.67) number of leaves while cypermethrin only had the least (8.03) (Table 1).

At 5 WAP, results showed that the mixture of cypermethrin and BS produced the tallest plant (66 cm) and was significantly different from the other treatments which were at par. Similar trend was observed in the number of leaves (Table 1).

Effect of baking soda and cypermethrin on disease traits of *Amaranthus cruentus*

Virus incidence was greatly reduced at 3 WAP to a mean value of 1.33% when baking soda was combined with cypermethrin compared to the control plant which had a mean incidence of 36.67%. The mean Amaranthus mosaic virus (AMV) incidence in baking soda-treated plant was 16.67%. There was no incidence of AMV in cypermethrin-sprayed plants at 3 WAP (Fig.1). Also, there was no incidence of AMV in plants sprayed with cypermethrin alone at 5 WAP. However, low incidences of 8.33% and 6.67% were obtained from plants sprayed with BS only and plants sprayed with mixture of BS and cypermethrin, respectively. Incidence of 25% was recorded for the control plants (Fig. 1). Insect damage was severe (2.67) on the leaves of the control plants at 3 WAP while the least leaf damage (1.67) was obtained when cypermethrin alone was used. Baking soda alone and its mixture with cypermethrin had a severity of 2. At 5 WAP, leaves were severely damaged (4.0) in the control plants while mild to moderate leaf damage was recorded in plants sprayed with BS only and mixture of BS and cypermethrin (Fig. 2). At 3 WAP, AMV severity in plants sprayed with BS and its mixture with cypermethrin

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was mild. At 5 WAP, the control plants had the highest AMV severity of 3 while the plants that received baking soda and its combination with pesticide treatment had severity of 2 (Fig. 3).

Relationship between plant growth parameters and disease traits

There was no significant correlation between plant growth parameters and disease traits at 3 WAP. A positive and significant (0.686*) relationship existed between leaf damage at 3 WAP and virus severity at 3 WAP. There was a significant correlation between disease traits at 3 WAP and disease traits at 5 WAP. Plant height at 5 WAP significantly correlated with number of leaves at 1% level of probability. The correlation between leaf damage and virus disease traits was positive and significant (Table 2). This implies that leaf damage could predispose plants to virus infections.

Occurrence of weed species in *Amaranthus cruentus* field

Plots that were sprayed with cypermethrin mixed with baking soda had the most weed species abundance. The least weed populations were recorded from plots sprayed with baking soda alone, this may suggest baking powder as a weed control agent. The treatments had no effect on weed species diversity as most weeds observed on the plots cuts across all treatment combinations. *Oldenlandia diffusa* had the least population and was observed only on plots sprayed with cypermethrin mixed with baking soda.

DISCUSSION

The study revealed that growth parameters were improved by baking soda. Greg and Williams (1993) reported that 2% baking soda and 1% oil solution proved most effective in controlling plant disease. This suggests that when plant diseases are controlled, plant growth will improve. The low incidence of AMV in *A. cruentus* sprayed with baking soda or its mixture with cypermethrin as compared with the unsprayed control suggests that baking soda is a good antiviral substance. Palou *et al*. (2001) have reported the effectiveness of salts such as sodium bicarbonate in the control of various pathogens of many crops. The severe damage on the leaves of the unsprayed plants could be attributed to the non-persistent nature of AMV transmission by *Aphid* species. Taiwo and Owolabi (2004) have reported that the commonest method of AMV transmission on the field was by insect transmission. The severity of leaf damage was reduced in plants sprayed with mixture of baking soda and cypermethrin. This agrees with the report of Abdel-Kader *et al*. (2012) which stated that combination of baking soda with chemical fungicide gives a better control in foliar disease than baking soda alone. The reduced severity of AMV in plants that were sprayed with baking soda and cypermethrin confirmed the study of Ziv and Zitter (1992) which reported the use of sodium bicarbonate for the control of cucurbit foliar diseases. The high number of weed species on the plot sprayed with mixture of baking soda and cypermethrin is an indication that the mixture provided a suitable environment for the weeds to thrive. The growth of wild plants within an agricultural field or in close proximity can serve as sources of inoculums or reservoirs of viruses to economical crops (Duffus, 1971).

CONCLUSION

This study concludes that half dose of synthetic pesticide mixed with baking soda for the management of pests and Amaranthus mosaic virus of *A. cruentus* gives maximum control. Baking soda alone can also be used for the control of viruses and their vectors for sustainable food production and security.

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Table 1. Effect of baking soda and cypermethrin on plant height and number of leaves of *Amaranthus cruentus*

	3 WAP		5 WAP	
Treatment	**Plant height (cm)**	**No. of leaves**	**Plant height (cm)**	**No. of leaves**
Cypermethrin	15.33^{ab}	8.03	33.75^{b}	14.50^{b}
Baking soda	11.53^{ab}	8.92	40.17^{b}	14.67^{b}
Cypermethrin + Baking soda	17.53^{a}	9.67	66.00^{a}	20.67^{a}
Control	10.07^{b}	8.83	30.83^{b}	11.83^{b}
NDMRT		NS		

Means followed by the same letter along the column are not significantly different according to New Duncan's multiple range test (NDMRT) at $P \leq 0.05$.

Table 2. Correlation between plant growth parameters and disease traits in *Amaranthus cruentus*

Variable	1	2	3	4	5	6	7	8	9	10
1	1	0.436^{ns}	0.40^{ns}	0.075^{ns}	0.22^{ns}	0.374^{ns}	0.275^{ns}	0.267^{ns}	0.37^{ns}	0.6*
2		1	0.152^{ns}	0.057^{ns}	0.167^{ns}	0.393^{ns}	0.103^{ns}	-0.003^{ns}	0.19^{ns}	0.432ns
3			1	0.407^{ns}	0.686*	0.039^{ns}	-0.125^{ns}	0.669*	0.706*	0.621*
4				1	0.574^{ns}	-0.541^{ns}	-0.662*	0.787**	0.829**	0.713**
5					1	0.187^{ns}	0.081^{ns}	0.683*	0.688*	0.672*
6						1	0.898**	-0.222^{ns}	-0.245^{ns}	-0.071^{ns}
7							1	-0.344^{ns}	-0.381^{ns}	-0.181^{ns}
8								1	0.923**	0.606**
9									1	0.800**
10										1

*Significant at 5% level of probability, **significant at 1 % level of probability, ns = not significant

1, 2, 3, 4 and 5 = Plant height, number of leaves, leaf damage, virus incidence and severity respectively at 4 weeks after planting.

6, 7, 8, 9 and 10 = Plant height, number of leaves, leaf damage, virus incidence and severity respectively at 6 weeks after planting.

Table 3. Distribution of weed species in *Amaranthus cruentus* field

Weed species	Cypermetrin	Baking soda	Cypermethri+Baking soda	Control
Cyperus rotundus	12	15	11	10
Celosia	10	12	10	8
Commelina bengalensis	10	8	7	12
Tridax procumbens	15	14	15	17
Phyllanthus amarus	11	10	18	15
Cynodon	17	12	17	10
Oldehlandia	-	-	12	-
Total	75	71	90	72

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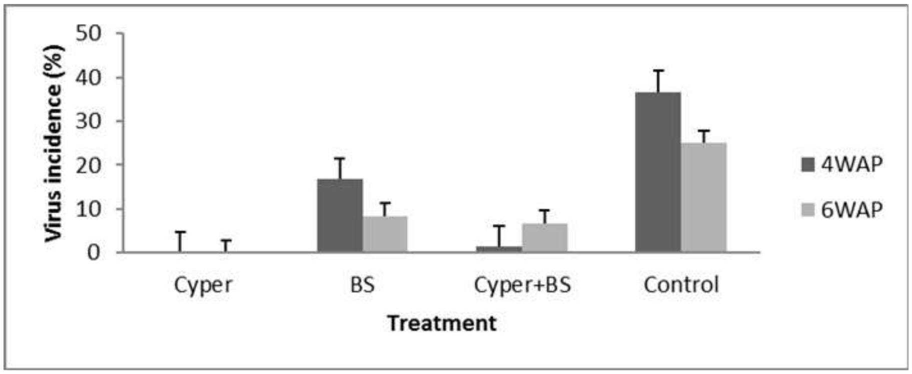

Fig. 1. Virus incidence in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

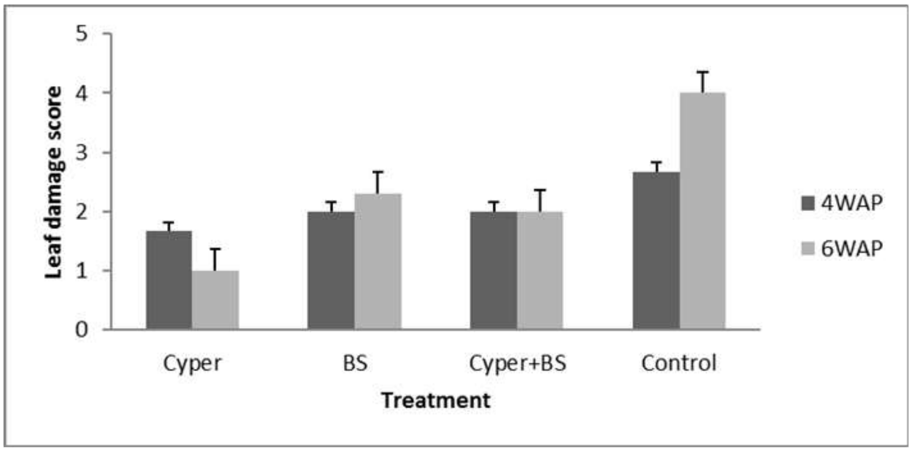

Fig. 2. Leaf damage in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

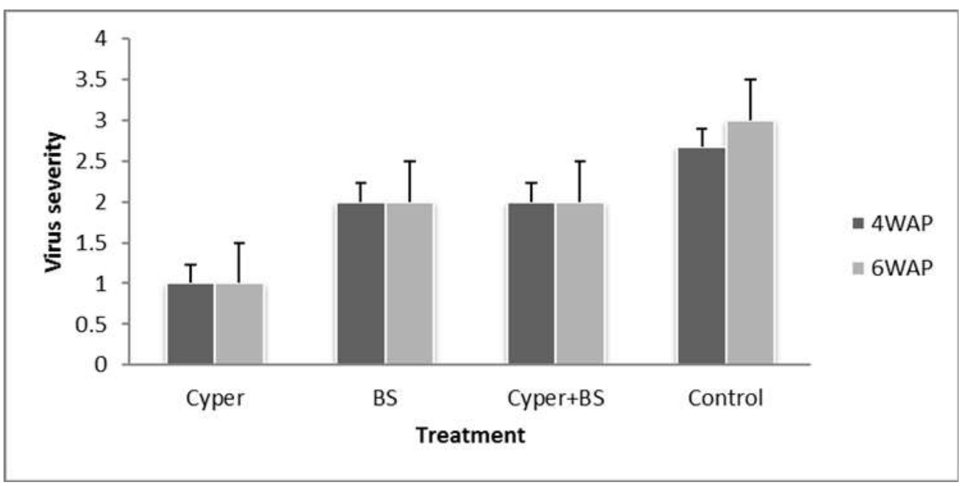

Fig 3. Severity of virus in *Amaranthus cruentus*
Cyper = cypermethrin, BS = baking soda

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Effect of NPK 20-10-10 Fertilizer Rates on the Performance of Carrot (*Daucus carota* L.) at Samaru, Zaria

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Abstract
A field trial was conducted during the 2018 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria in the Northern Guinea Savannah Ecology to determine the ''effect of NPK 20-10-10 fertilizer rates on the performance of carrot (Daucus carotaL.) at Samaru, Zaria''. The trial was laid out in a randomized completely block design (RCBD) with five treatments; 0, 90, 120, 150 and 200 kg ha^{-1} of NPK 20-10-10 fertilizer, replicated four times to give a total of 20 plots. The crop established very well, all cultural practices were executed as at when due. Data was collected on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total shoot yield ha^{-1}. All data collected was analyzed statistically using statistical analysis system software version 8. Means were compared using Duncan's multiple range test at 5% level of probability. The effect of NPK 20-10-10 fertilizer rates on the performance of carrot were significant on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total shoot yield ha^{-1}. Application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer rate produced significantly higher growth and fresh total shoot yield of carrot, while the control produced significantly lower similar traits.
Keywords: *Carrot, NPK 20-10-10 fertilizer, rates, growth, fresh total shoot yield.*

INTRODUCTION

Carrot (*Daucus carota* L.) is an important vegetable which is ranked third among the succulent vegetables in the world (Dawuda *et al*., 2011). In Nigeria, it is also one of the exotic vegetableswith high value and great demand in urban centres and it is a potential export crop (Abdel-Razik, 1996; Dawuda *et al*., 2011). The edible roots are nutritious and contain water, protein, ash, vitamins and mineral (Dawuda *et al*., 2011). Carotene which is extracted from the roots is used in colouring margarine and for improving the colour of egg yolk when added to layer feed. The leaves and mature roots are used in the preparation of animal feed (Mehedi *et al*., 2012). Carrot which belongs to the family Apiaceae is a biennial and is usually cultivated as an annual crop in the tropics (Alom, 2004; Mehedi *et al*., 2012). The cropis tolerant to soil pH of 5.5 to 6.5 and it requires a deep and well-drained loamy soil with high amount of organic matter (Mehwish *et al*., 2016). Haque, (1999); Vithwel and Kanaujia (2013) recommended the application of 70-120 kg ha^{-1} N, 30- 35 kg ha^{-1} P and 0-55 kg ha^{-1} K for high yield of carrots. Production of carrot could be increased significantly through increase of per hectare yield. This can be done in many ways, of which the most important one is the judicious application of different fertilizers and manures. Among various factors responsible for low production of carrot, nutrient management is of prime importance for maintaining higher yield and soil fertility. It has been reported that neither the chemical fertilizer alone nor the organic manure are able to sustain the crop productivity and soil fertility (Hossain, 2005; Vithwel and Kanaujia, 2013). The increasing use of chemical fertilizers to increase vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism and human being. The escalating prices of chemical fertilizers and its detrimental impact on the soil, environment and human health urged the farmer to adopt organic sources of plant nutrient that would offer the crops a sustainable production and soil fertility (Alam *et al.*, 2010). Besides fertilizers, there are several sources of plant nutrients like organic manures, bio-fertilizers etc. These nutrients sources not only reduce quantity of chemical fertilizers but also improve soil fertility (Kropisz, 1992; Mehedi *et al.*, 2012). The use of organic manures in helps mitigating multiple nutrient deficiencies. Application of organic manures to acidic soil reduces the soluble and exchangeable Al temporarily by forming complex and provides better environment for growth and development in plants in addition to improvement in physical, chemical and biological properties of soil in plants (Mehedi *et al.*, 2012). Bio-fertilizers have also emerged as promising components of nutrient supply system. Application of bio-fertilizers which is environment friendly and low cost input, with organic and inorganic fertilizers as part of an integrated nutrient management strategy and play significant role in plant nutrition.

The yield and yield contributing characters of carrot were influenced by the application of NPK fertilizers. The highest marketable yield was obtained by the application of NPK fertilizers at 140 kg, 40 kg and 80 kg ha^{-1} respectively (Parwaiz *et al.*, 2014). Nitrogen at 200 kg ha^{-1} produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight but nitrogen at150 kg ha^{-1} produced the maximum root length, root diameter, fresh root weight and the highest yield 53.37 tons ha^{-1}(Uzma and Fozia, 2014). But indiscriminate use of inorganic fertilizer changes physical, chemical and biological properties of soil and creates problem to the environment and health hazards due to the toxic residual effects. Application of different manures increases the yield of carrot. The highest gross and marketable yields (67.47 and 60.93 t ha^{-1}) were obtained from the treatment of inorganic fertilizers (290 kg Urea, 225 kg TSP and 250 kg MP) plus 5 t MOC ha^{-1} (Rumpel *et al.,* 1998; Alam *et al*., 2010). Organic manures like cow dung improves soil texture, structure and aeration. Inorganic fertilizer in combination with organic manures also increases the carrot yield (Vieira *et al.,* 1998; Mehwish *et al*., 2016). A large number of scientists have studied the effect of organic manures on growth and yield of carrot. Application of 300-450 kg ha^{-1} NPK 20-10-10 fertilizer before planting has been recommended for improved growth and shoot yield of the carrot by Dawuda *et al.* (2011). Habimana *et al.* (2011) has recommended the application of 10-20 t ha^{-1} poultry manure for improved growth and yield of carrot in the tropics. The average yield of carrot estimated at 8-12 t ha^{-1} for the tropics is far below the world average estimated at 21 t ha^{-1} (Vithwel and Kanaujia (2013) have attributed the low yield of horticultural crops in the tropics to poor soil fertility.

Farmers in Nigeria especially Zaria, have not adopted a particular rate of NPK 20-10-10 fertilizer application; some apply higher rates, while others apply lower rates. This variation in the rates of NPK 20-10-10 fertilizer application has not resulted into yield increases in carrot. Therefore, optimum rate of NPK 20-10-10 fertilizer application or any source of nutrition in carrot would increase the growth, yield and quality as well. The objective of the study was to determine the optimum rate of NPK 20-10-10 fertilizer

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application that would optimize its use as source of nutrient for carrot growth and yield in Samaru, Zaria.

MATERIALS AND METHODS

Site Location

The experiment was conducted at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria located in the northern guinea savanna zone, situated on Latitude $11^{0}11$\`N and Longitude $07^{0}38$\`E at an altitude of 686m above sea level. The area has a tropical wet and dry climate with mean annual temperature and rainfall of 29^{0}C and 900mm-1000mm, respectively (Field Survey, 2018).

Experimental Design and Treatments

The experimental design used was randomized complete block design (RCBD), consisting of five treatments; NPK 20-10-10 fertilizer application rates at 0, 90, 120, 150 and 200 kg ha^{-1} and was replicated four times.

Sowing and Crop Management

Seeds of carrot (*Daucus carota* L.*)* was sown in the field at the rate of three seeds $hole^{-1}$ which were later be thinned to two seedlings $hole^{-1}$.

Data Collection

Data was collected in the field on plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$, leaf area (cm^2) $plant^{-1}$, fresh total shoot yield $plant^{-1}$ (gm), fresh total shoot yield ha^{-1} (kg).

Statistical Analysis

All data collected were analyzed statistically using statistical analysis system (SAS) software version 8. Means were separated using the least significant difference (LSD) at 5% level of probability (Rangaswamy, 2010).

RESULTS

Soil Physical and Chemical Analysis used for the Experiment

Table 1 shows the physical and chemical analysis of the soil used for the trial during the 2018 cropping season. The soil contains a higher proportion of sand (46%), higher silt (58 %), low clay (7.00 %) and moderate organic carbon (1.24%). The chemical analysis also show that pH in water was (6.59), the total nitrogen was low (0.142 %), low available phosphorus (32.33ppm), low available potassium (0.33 mg kg^{-1}), low available calcium (3.78 mg kg^{-1}), low available sodium (0.77 mg kg^{-1}), low available magnesium (1.42 mg kg^{-1}) and low cation exchange capacity (7.22 mg kg^{-1}).

Plant height (cm)

Table 2 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on plant height. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1}significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference (P>0.05) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on plant height.

Number of leaves plant^{-1}

Table 2 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on number of leaves $plant^{-1}$. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates on number of leaves $plant^{-1}$, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly

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produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference (P>0.05) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on number of leaves plant^{-1}.

Number of branches plant^{-1}

Table 3 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on number of branches plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1}significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference (P>0.05) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on number of branches plant^{-1}.

Leaf area (cm^2) plant^{-1}

Table 3 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on leaf area plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on leaf area plant^{-1}.

Fresh Total Shoot Yield (gm) Plant^{-1}

Table 4 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on fresh shoot yield plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on fresh shoot yield plant^{-1}.

Fresh Total Shoot Yield (kg) ha^{-1}

Table 4 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on fresh shoot ha^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on fresh shoot ha^{-1}.

DISCUSSION

Crop performance is usually limited by inadequacy of essential nutrients. The results of this trial highlighted the effect of NPK 20-10-10 fertilizer rates in terms of growth and fresh total shoot yield ha^{-1} of in the field carrot. The consistently poor performance of carrot in the control plots of no NPK 20-10-10 fertilizer applied showed that when nutrients are available in adequate amounts, there is tendency for plants to produce at their optimum potential. The results of this experiment showed that NPK 20-10-10 fertilizer application especially at 200 kg ha^{-1} significantly influenced growth and fresh total yield of carrot. Application of NPK 20-10-10 fertilizer rates improved growth attributes of carrot. The highest value for

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growth traits were equally maintained by the application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer. Also, growth characters were also considerably improved by the application rates of 0, 90, 120 and 150 kg ha^{-1} of NPK 20-10-10 fertilizer. This kind of positive influence of NPK 20-10-10 fertilizer on carrot fresh total yield had been reported by Mehedi *et al*. (2012); Dawuda *et al.* (2011). Dawuda *et al.* (2011); Mehwish *et al.* (2016) who indicated that higher dry matter production at higher rates of NPK 20-10-10 fertilizer favoured the development of plants which resulted into the production of more fruits in okra. When nutrients were available in the right proportion, the photosynthetic activity of plants were considerably favoured. This improved light interception, dry matter production, accumulation and partitioning (Habimana *et al.,* 2011). Significant enhancement of shoot production by carrot with NPK 20-10-10 fertilizer application corroborates the report of (Uzmaand Fozia, 2014 on potato; Vithwel and Kanaujia, 2013) on carrot. This was linked to the positive effect of adequate amount of nutrients for plant use. Nutrients such as N, P and K improved the vegetative growth, synthesis and translocation of photosynthate from the sources to the sink and significant increase in fresh shoot yield of carrot (Mehedi*et al*., 2012). Application of 200 kg ha^{-1} gave the highest fresh total yield ha^{-1}, while the control gave the lowest fresh total yield ha^{-1}. This implied that adequacy in the supply of nutrients was necessary for optimum carrot growth and fresh total shoot yield.

Conclusion

From the results, it was observed that the effect of NPK 20-10-10 fertilizer on the performance of carrot were significant at 6 and 8WAS in the field on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1}and fresh total yield ha^{-1}. Application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer produced significantly higher growth and fresh shoot yield, while the control significantly produced lower similar traits. Farmers who are into carrot production in Samaru-Zaria, are advised to use NPK 20-10-10 fertilizer rate of 200 kg ha^{-1} because it produced significantly higher growth and fresh total shoot yield than the other treatments.

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Table 1: Physical and Chemical Analysis of the Soil from the Experimental Site during the 2018 Cropping Season.

Composition	Value
% Clay	7.00
% Silt	58
% Sand	46
Textural class	Loam
pH ratio	1: 2.40
H_20	6.59
0.01M $CaCl_2$	6.22
% OC	1.24
% TN	0.142
AP (ppm)	32.33
Exchangeable Bases (Cmol kg^{-1})	
Ca	3.78
Mg	1.42
K	0.33
Na	0.77
CEC	7.22

Source: Department of Soil Science, Faculty of Agriculture, ABU Zaria

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Table 2: Effect of NPK Fertilizer 20-10-10 Rates on Growth Parameters of Carrot at Samaru, Zaria.

	Plant height (cm)			Number of leaves plant^{-1}		
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	3.92	4.27	5.82	1.45	2.22	3.41
90	3.84	4.33	6.34	2.43	2.24	3.68
120	3.97	4.37	6.62	2.54	2.26	3.78
150	3.99	5.51	7.19	2.66	3.33	4.21
200	3.91	5.79	7.88	2.72	3.48	5.34
LSD	2.84	0.27	0.30	2.81	0.24	0.31

Table 3: Effect of NPK Fertilizer 20-10-10 Rates on Growth Parameters of Carrot at Samaru, Zaria.

	Number of branches plant^{-1}			Leaf area (cm^2) plant^{-1}		
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	1.12	2.13	3.34	22.01	22.33	23.81
90	1.25	2.21	3.84	23.12	24.64	26.37
120	1.34	2.24	3.92	23.35	24.66	28.66
150	1.42	3.11	4.20	23.58	33.11	32.41
200	1.44	3.48	4.63	24.04	34.68	33.29
LSD	1.21	0.18	0.30	1.51	2.15	2.23

Table 4: Effect of NPK Fertilizer 20-10-10 Rates on Fresh Total Shoot Yield of Carrot at Samaru, Zaria.

Treatments	Fresh total shoot yield (gm) plant^{-1}			Fresh total shoot yield (kg) ha^{-1}		
	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	22.16	23.24	24.26	120.04	122.24	123.61
90	22.20	23.31	24.34	123.28	124.33	216.64
120	22.32	23.34	24.36	123.38	124.74	218.87
150	22.36	24.36	25.18	123.60	133.22	312.42
200	23.41	25.34	25.23	125.12	134.84	323.38
LSD	1.12	1.18	1.20	3.32	3.35	3.42

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Growth and Yield Response of Okra (*Abelmoschus esculentus* L.) to Organic and Inorganic Fertilizer in Lafia, North Central Nigeria

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Abstract

The trial was conducted at the research farm faculty of agriculture, Nasarawa State University, Shabu-Lafia in rainy season of 2017; aim at evaluating the effectiveness of using organic, inorganic and combination of organic + inorganic manure on the growth and yield of okra. The study was made up of sixteen treatments consisting of different rates of 10t/ha poultry,10t/ha cow dung, 200 and 100kg/ha NPK fertilizer and 2.5l/ha and 1.5l/ha Zn. Laid in a randomized complete block design (RCBD) and replicated three times. The result showed that Organic fertilizer, inorganic fertilizer and organic + inorganic fertilizer combined had a significant (p<0.05) increased on both growth and yield parameters. Application of PM + full NPK + full MN produced the highest number of leaves (8.23, 10.37) in week 4 and 6 after planting. Application of PM + full NPK + full MN produced the tallest okra plants (35. 12 and 64. 91cm) in week 4 and 6 after planting. This is statistically the same with application rate of PM + ½ NPK + ½ MN. Also, application of PM + full NPK + full MN produced okra plants with the biggest stem girth (4.65, 8.18 and 10. 83cm) in week 2, 4 and 6 after planting compared with other rates. Application of PM + ½fullNPK + full MN produced the highest number of okra fruits (52.17), fruit length (4.90cm) and fruit diameter of 3.60cm. Also, application of PM + full NPK + full MN produced the highest weight of okra fruits per plant (191.39g), and total weight of fruit yield of 5.104 t ha^{-1} The control plots produced the lowest weight of okra fruits 86. 24g per plant, and total weight 2.30 t ha^{-1}. This study, demonstrated the importance of complete soil nutrition in the growth and yield of okra with the combination of organic and inorganic fertilizers mixed with micronutrients producing the best growth, yield of okra in southern guinea savanna agroecological zone of Nigeria.

Keywords*: Response, Okra, Organic, Inorganic, Micronutrient*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L) Moench) is a popular vegetable crop grown in most parts of Nigeria and in other tropical and sub-tropical countries. It is a member of Malvaceae, a flowering plant of the mallow family valued for its edible fruits. The importance of okra as a vegetable crop lies in its 'drawing quality' that aids easy consumption of bulky staple foods like Gari, Fufu and pounded yam (Agbogidi and Nweke, 2005). The fruits can be conserved by drying; the roasted seed is considered as coffee substitute; the leaves, flower buds, flowers and calyces can be eaten greens (Ajari *et al*., 2003). The tender pods contain vitamins A and C and traces of B vitamin. Okra provides good source of calcium and other body building materials that contribute to healthy living (Schippers (2000). Despite the importance of okra in Nigerian diet, farmers are facing a lot of challenges concerning its production; especially on the soils of southern guinea savanna agro ecological zones. There is rapid depletion of soil nutrients and poor physical condition of the savanna soils which constitute strong limitations to crop production (Salako, 2003). Therefore, these soils must be fertilize with adequate macronutrients in other to keep them productive (Ndor *et al*., 2012). The most common fertilizer known and generally used by peasant farmers on their farms is the chemical fertilizer. The introduction and promotion of chemical fertilizers showed promise and produced higher yield of okra. However, the aftermath effect is increased soil acidity and nutrient imbalance (Ansari and Ismail, 2001). Also, the high cost and untimely availability of chemical fertilizers have made their accessibility to our peasant farmer a herculean task to accomplish. Therefore, the choice of organic manure as an alternative has become imperative. Organic manure generally improve the soil physical, chemical, biological properties along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop production. In addition, they generally have greater residual effect on subsequent crops than chemical fertilizer, due to slow release of their nutrients over time (Dauda *et al.,* 2008). However, Aulakh and Grant (2008) advocated for the introduction of integrated nutrients management; because Organic manure alone was not meeting the nutritional needs of crops. Since they contain a comparatively less quantity of nutrients compared to inorganic fertilizers. Therefore, there is the need to integrate the two forms (organic and inorganic fertilizer) together in order to achieve better crop yields. Many studies have been conducted outside the southern guinea savanna zone on the effect of organic and inorganic fertilizers on the growth and yield of okra (Okwuagwu *et al*., 203; Akande *et al*., 2010 and Olaniyi *et al*., 2010). Therefore, this study is aim at evaluating the effect of organic, inorganic and combination of organic and inorganic manure on growth and yield of okra

MATERIALS AND METHODS

Experimental Site

The study was conducted at the Research Farm Faculty of Agriculture, Nasarawa State University, keffi, Shabu-Lafia Campus Nasarawa State in rainy season of 2017. The area lies between latitude 080 33'N, longitude 080 33'E and at an altitude of 181.53m above sea level. The area falls under Koppens climatic classification of AW that is tropical rainy climate with distinct dry season in winter. The rainy season span a period of seven months (April- October) with an annual rainfall of about 1200-2000mm. The daily maximum temperature ranges from 20.0ºC – 38.5ºC and daily minimum ranges from 18.7ºC – 28.2ºC. The months of February to early April are the months that have the highest maximum temperature while the lowest maximum temperature months are recorded in December and January because of the prevailing cold harmattan wind from the northern part of the country at this period. The relative humidity rises as from April to a maximum of about 75-90 percent in July (Jayeoba, 2013).

Treatments and Experimental Designs

The study was made up of sixteen treatments consisting of different rates of poultry manure, cow dung, NPK fertilizer and Zn. Laid in a randomized complete block design (RCBD) and replicated three times. Soil sample was initial collected at a depth of 0-15cm with soil auger before incorporating poultry manure. Soil samples collected were bulked together, air-dried and gently crushed, then passed through 2mm sieve to obtain a homogeneous particle size, after which both physical and chemical Properties of these samples were determined. The Cow dung, and poultry manure were collected separately and air-dried, then

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passed through 2 mm sieve mesh to obtain a homogeneous particle sizes, after which standard laboratory procedures as described by (Agbenin, 1995) were used for analysis of their chemical properties.

The land was cleared, ridges were manually constructed, cow dung and poultry manure were incorporated into the plots at different rates, and the incorporated manures were allowed to cure for 2 weeks before planting. Planting was carried out in June at a spacing of 50cm X 50cm. Three seeds were sown per hole and later thinned to two plants per stand at two weeks after sowing (WAS). Weeding was done manually using small hoes at four weeks after sowing and supplementary weeding was also carried out through hand pulling before the maturity of the crops. The okra plants were sprayed against beetles and caterpillars, by applying Cyper force which has a systemic and contact action, at the rate of 0.5 litres per hectare (30 mls per 15 litres of water) four times during plant growth period, Spraying starts from 3 weeks after seedling emergence, and stopped before the plant starts fruiting. Five plants were randomly sampled from each plot in the field and tagged for observation of growth and yield of okra. The growth data (plant height, number of leaves, stem diameter and number of branches). Yield parameter (Days to 50%, number of fruit per plant, fresh fruit weight). The amended soil and crop data collected were subjected to analysis of variance using GENSTAT (2008 Ed), and where there was a significant difference; the means were separated using F-LSD at 5% probability level.

RESULTS AND DISCUSSION

The soils in the experimental site before cropping was sandy loam (Table 1); low in nitrogen, phosphorus, potassium, organic carbon and also cation exchange capacity. The soil was acidic in nature with pH of 5.63; high in percent sand fraction (88.00) and also very high in percentage base saturation of 90.00%. The poultry manure and cow dung used in (Table 2) were very high in both organic matter 35.12% and 31.32% respectively; nitrogen 2.81% and 1.61% respectively; potassium 4.41% and 0.53% respectively. While the pH was almost neutral (6.70) in poultry manure; but was severely alkaline with a pH of 8.12 in cow dung manure.

Effect of organic, inorganic, combination of organic and inorganic fertilizer on growth parameters of okra

Organic fertilizer, inorganic fertilizer and organic + inorganic fertilizer combined had a significant ($p<0.05$) increased on number of leaves, plant height and stem girth of okra (Table 3). Application of10t/ha PM + 200kg/ha NPK + 2.5l/ha MN produced the highest number of leaves (8.23, 10.37) in week 4 and 6 after planting. The control plots in Lafia produced the lowest number of okra leaves (3.53, 4.90 and 6.27) at week 2, 4 and 6 after planting. Application of10t/ha PM + 200kg/ha NPK + full MN produced the tallest okra plants (35. 12 and 64. 91cm) in week 4 and 6 after planting. This is statistically the same with application rate of10t/ha PM + 100kg/ha NPK + 1.5l/ha MN. The control plots in Lafia produced the shortest okra plants (13.93, 27.93 and 38.28cm) at week 2, 4 and 6 after planting. Also, application of10t/ha PM + 200kg/ha NPK + 2.5l/ha MN produced okra plants with the biggest stem girth (4.65, 8.18 and 10. 83cm) in week 2, 4 and 6 after planting compared with other rates. The control plots recorded the lowest stem girth of okra (2.29, 4.09 and 6.06cm) at week 2, 4 and 6 after planting respectively

Effect of organic, inorganic, combination of organic and inorganic

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fertilizer on yield and yield parameters of okra

The result on table 4 showed that organic fertilizer, inorganic fertilizer and organic + inorganic fertilizer combined had a significant ($p<0.05$) increased on all yield and yield parameters (number of fruit, fruit length and fruit diameter) of okra. Application of10t/ha PM + 200kg/ha NPK + 2.5l/ha MN produced the highest number of okra fruits (52.17), fruit length (4.90cm) and fruit diameter of 3.60cm. The control plots produced the lowest number of okra fruits (18.27), fruit length of (2.24cm) and fruit diameter (2.12cm). Also, application of PM + full NPK + full MN produced the highest weight of okra fruits per plant (191.39g), and total weight of fruit yield of 5.104 t ha^{-1} The control plots produced the lowest weight of okra fruits 86. 24g per plant, and total weight 2.30 t ha^{-1}.

DISCUSSION

The significant response of growth parameters of okra to the application of both organic and inorganic fertilizer was because of the poor soil fertility of the experimental site (Table 1). Therefore, when external manure was applied in form of organic and inorganic fertilizer; the nutrients were adequately released and available within the soil because of reduction in leaching and nutrient immobilization, thereby increasing nutrients uptake by okra plant and subsequently translating to luxuriant vegetative growth of okra plant. This finding is in consonance with the results obtained earlier by Adewole, and Ilesanmi, (2012), when they were working on the effect of different soil amendments on the growth and yield of okra in a tropical rainforest of Southwestern Nigeria. On the yield parameters of the okra, a similar trend was observed where most of yield parameters were significantly increased as a result of application of organic and inorganic fertilizer or combination of the two. Comparatively, application of only poultry manure produced significantly higher okra yield compare to either cow dung or NPK fertilizer. However, application of mixture of poultry manure, 200kg/ha NPK and full micro nutrients treatment (10t/ha PM + 200kg/ha NPK + 2.5l/ha MN); produced significantly the best in terms of yield and yield components of okra. This is in tandem with the result reported by Akande *et al.,* (2010), whose work on response of okra to organic and inorganic fertilization; revealed that, the combined ½NPK + ½PM treatment recorded the highest figures for the yield parameters (number of fruits, fruit length, fruit diameter and fresh fruit yield) of okra. Dennis *et al*., (1994) indicated that the combination of organic and mineral fertilizers does not only improve the physical status of the soil, but also improves crop yield. The combined application rates of 75kg NPK and 3 $t.ha^{-1}$ organo mineral fertilizers gave the best okra performance compared to other treatments (Olaniyi *et al*., 2010). The importance of inorganic fertilizers in combination with organic manures and micro elements in sustainable crop production quality and soil health have been reported by several authors (Bhukta, 2000; Bairwa *et al*.; 2009; Solanke *et al*.; 2009; Adeleye *et al*.; 2010; Choudhary *et al*.; 2015). The findings of these workers revealed that the integrated sources of nutrients increased growth, yield and quality of vegetables as compared with conventional method of sole application of 100% recommended dose of chemical fertilizers.

CONCLUSION

From this study, it can be concluded that mixture of10t/ha PM + 200kg/ha NPK + 2.5l/ha MN could be the optimal rates of

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organic manure, inorganic fertilizer and micronutrients that can enhanced a good growth, yield and environmentally friendly production of okra in southern guinea savanna agro ecological zone of Nigeria. This results also demonstrated that, integrated nutrients management practices increase nutrient use efficiency and improve soil health and sustainability. Strong and convincing evidence indicates that in practice it could be an innovative and environment friendly practice for sustainable growth, yield and quality vegetables production.

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Table 1: Physical and chemical properties of soil at experimental sites at 0-15cm depth

Soil Properties	**Lafia**
Physical properties	
Sand%	88
Silt%	3.4
Clay %	8.6
Textural class	Loamy sand
Chemical properties	
pH in H_20	5.63
Organic carbon%	1.38
Organic matter%	2.37
Total nitrogen(gkg^{-1})	0.21
P (PPM)	3.01
Ca ($cmolkg^{-1}$)	3.48
Mg ($cmolkg^{-1}$)	2.63
K ($cmolkg^{-1}$)	0.25
Na ($cmolkg^{-1}$)	0.27
EA(cmolkg)	0.66
CEC ($cmolkg^{-1}$)	6.63
BS%	90.94

Table 2: Chemical Properties of Poultry manure and Cow dung

Chemical properties	**Poultry manure**	**Cow dung**
pH in H20	6.70	8.12
N (%)	2.81	1.61
P (%)	0.78	0.71
K (%)	4.41	0.53
Ca (%)	1.13	1.01
Mg (%)	0.51	0.21
Na (%)	0.31	0.50
C (%)	20.42	18.21
OM (%)	35.12	31.32

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Table 4: Effect of organic and inorganic fertilizer on growth parameter of okra

	Number of leaves			Plant height (cm)			Stem girth (cm)		
Treatments	2was	4was	6was	2was	4was	6was	2was	4was	6was
Control	3.53f	4.90l	6.27m	13.643g	27.933c	38.283e	2.290l	4.089j	6.063m
Control	3.70ef	6.97e	9.33e	15.180f	32.023b	62.263b	4.197e	7.260e	9.153f
10t/ha PM	3.93bcd	6.03i	7.53j	18.520bc	33.447b	55.740c	2.433jk	5.403h	8.343i
10t/ha CD	3.83cde	5.57k	6.80l	17.190de	31.203b	52.187d	2.373kl	4.603i	7.077l
200kg/ha (NPK)	3.77de	7.23d	9.53de	16.110ef	33.440b	62.990b	4.330d	7.477de	9.620e
10t/ha PM + ½ MN	3.70ef	7.34d	9.73cd	15.993ef	33.723b	54.703c	4.413cd	7.620cd	9.857d
10t/ha PM + full MN	3.97bc	6.27h	7.70ij	19.023abc	28.237c	56.340c	2.497hij	5.693g	8.627h
10t/ha CD + ½ MN	4.03b	6.43gh	7.87hi	19.303ab	28.483c	56.720c	2.560ghi	5.780g	8.833g
10t/ha CD + full MN	3.83cde	5.73jk	7.00kl	17.707cd	26.470c	52.907d	2.437jk	4.713i	7.547k
200kg/ha NPK + ½ MN	3.93bcd	5.83j	7.20k	17.840cd	26.663c	53.713d	2.4	4.837i	7.823j
200kg/ha NPK + full MN	3.80cde	7.57c	9.87c	15.847ef	34.127b	54.077b	4.493bc	7.827bc	10297c
10t/kg PM + ½ MN	4.03b	6.63fg	8.03gh	19.683ab	28.787c	55.777c	2.607gh	5.853g	9.117f
10t/ha CD + ½ NPK	3.83cde	7.83b	10.10ab	16.953de	34.623ab	64.540a	4.540h	7.973ab	10.580b
10t/ha PM + ½ NPK + ½ MN	3.93bcd	8.23a	10.37a	17.117de	35.127ab	64.917a	4.650a	8.183a	10.827a
10t/ha PM + full NPK +full MN	4.10ab	6.83ef	8.20fg	19.967a	29.277b	56.220c	2.670g	6.157f	9.530e
CD + ½ NPK + ½ MN	4.23a	7.00e	8.40f	20.197a	29.483b	56.543c	2.783f	6.323f	9.687de
SE ±	0.02	0.04	0.03	0.041	0.681	0.133	0.234	0.236	0.936

Means followed with the same letter are not statistically different at 5% level of significance

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Table 4: Effect of organic and inorganic fertilizer on yield and yield parameter of okra

Treatments	Fruit length	Fruits diameter	Number of fruit	Yield per plant(g)	Yield kg/ha	Yield (t/ha)
Control	2.243n	2.121l	18.267j	86.243i	2300i	2.300i
Control	3.528i	3.020f	40.067e	165.153cd	4404d	4.403cd
10t/ha PM	3.020l	2.578i	27.033hi	124.067f	3308f	3.310f
10t/ha CD	2.875m	2.344k	23.900i	99.573h	2655h	2.657h
200kg/ha (NPK)	3.674g	3.134e	40.733de	168.723cd	4499d	4.500cd
10t/ha PM + ½ MN	3.879d	3.254d	44.000cd	175.953bc	4692b	4.690bc
10t/ha PM + full MN	3.225k	2.674h	30.667gh	136.717e	3646e	3.647e
10t/ha CD + ½ MN	3.373j	2.764g	32.000g	147.303e	3928e	3.927e
10t/ha CD + full MN	3.005l	2.464j	24.567i	111.220g	2966g	2.963g
200kg/ha NPK + ½ MN	3.215k	2.594i	27.933hi	121.553fg	3241fg	3.243fg
200kg/ha NPK + full MN	4.004c	3.334c	47.300bc	182.697ab	4872b	4.873ab
10t/kg PM + ½ MN	3.595h	2.797g	35.900f	163.190d	4352d	4.353d
10t/ha CD + ½ NPK	4.134b	3.474b	49.767b	184.223ab	4913b	4.913ab
10t/ha PM + ½ NPK + ½ MN	4.904a	3.604a	52.167a	191.390a	5104a	5.103a
10t/ha PM + full NPK +full MN	3.735f	2.974f	37.100ef	164.937cd	4398cd	4.397cd
CD + ½ NPK + ½ MN	3.845e	3.104e	39.367ef	170.260cd	4540d	4.543bc
SE ±	0.11	0.12	0.25	0.921	14.547	0.024

Means followed with the same letter are not statistically different at 5% level of significance

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Growth and Yield Response of Tomatoes to Inorganic and Organic Fertilizer in Southern Guinea Savanna Zone of Nigeria

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Abstract

The study was conducted at the research farm faculty of agriculture, Nasarawa State University, Shabu-Lafia in rainy season of 2017; with the aim of evaluating the effect of organic and inorganic manure on growth and yield of tomato in Southern Guinea Savanna ecological zone. The treatments consists of three levels of Poultry Manure (PM) (5, 10, and 15 tons/ha), three levels of each NPK (15: 15: 15) Fertilizer (integrated with Zinc) (200, 250 and 300kg/ha) and a mixture of the three levels of Poultry Manure and NPK Fertilizer (integrated with Zinc) (200kg/ha) were laid in a randomized complete block design (RCBD) and replicated three times. The result show that application of poultry manure single, NPK and Zinc significantly (p<0.05) increased growth parameters. Application of 15t/ha PM+200kg/ha NPK +Zn produced the highest number of tomato leaves (16.67, 24.33 and 33.33), the tallest tomato plants (34.25, 42.64 and 50.41cm) and highest number of tomato branches (8.67, 10.67 and 11.33) at 2, 4 and 6 weeks after transplanting (WAT) respectively. The control plots did not produced any branch at 2, 4 and 6 WAT. Also, application of poultry manure single, NPK and Zinc significantly (p<0.05) increased number of tomato per plant, fruit diameter, number of fruits per plot and total yield per hectare of tomato. Application of 10t/haPM+200kg/ha NPK +Zn produced the highest number of tomato per plant (33.00); the widest fruit diameter (3.45cm) of tomato; highest fruits weight per plant of 603.70g and total yield of tomato (8.52 t/ha) were produced by application of 15t/haPM+200kg/ha NPK +Zn. This results is statistically similar with the application of 10t/haPM+200kg/ha NPK +Zn. The control plots recorded the lowest number of 6.00 tomato per plant, the smallest fruit diameter of 2.36cm, lowest fruits weight per plant of 79.20g and the smallest total yield of 1.13 t/ha of tomato. This study, demonstrated the importance of complete soil nutrition in the growth and yield of tomato with the combination of organic and inorganic fertilizers mixed with micronutrients producing the best growth, yield of tomato in Southern Guinea Savanna agroecological zone of Nigeria.

***Keywords**: Growth and yield, tomato, organic, inorganic fertilizer, Micronutrient*

INTRODUCION

Tomato (*Lycopersicon esculentum L.*) belongs to the family Solanaceaes; it is one of the major and important vegetable grown in the World. Although, it is believe that tomatoes originated in the Andes Mountains of Peru and were brought to Central America and Mexico by emigrating Indians. The first written record of the tomato dated to the 1550s when European explorers returned home from Mexico with tomato plants. Today, tomato is grown commercially in about 159 countries, its major producers as at 2009 were China, the United States, India, Turkey, Egypt, Italy, and Iran (Ibrahim et al., 2015).

In Nigeria Total cultivation area for the production of tomato was 127,000 hectares and the production quantity was 889,000 tons given an average of 7 tons per hectare, Law-ogboma, K.E and R.K.A Egharevba (2009).

In Nigeria, tomato is a special ingredient in the food of both the poor and the rich. Tomato stew is eaten with relish, especially on Sundays and during festivals. Tomatoes have both nutritional and medicinal values. Tomato is a source of carbohydrates, fats, proteins, vitamins and minerals which when eaten makes the eye brighter than using cosmetics on it (Gojale, 2002).

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Only small scale peasant farmers are mostly involved in production of tomatoes in family gardens under degraded soil conditions in the Southern Guinea Savanna and Rain Forest regions of Nigeria (Ogunwole *et al.*, 2006). However, large scale tomato production is found in the northern Guinea and Sudan Savannah `zones of Nigeria, where relatively high yields are realized by planting between June and December (Bodunde *et al.*, 1996). This yield is below African average of 20.5 tons per hectare (FAO; 2003).

Decreasing soil nutrient quality and rising cost of inputs, especially fertilizer, plague large scale tomato production in Nigeria; and this resulted to dwindling yields of tomato plants in the country (Ogunwole *et al.*, 2006). Prominent among the factors that account for the low tomato yield in Nigeria are scarcity and improper application of inorganic fertilizer which has ruined tropical soils (IFDC; 2005). Therefore, these tropical soils must be supplemented with adequate macronutrients in other to keep them productive (Ndor *et al.*, 2013). Most of the peasant farmers in this zone are mostly familiar with the use of chemical fertilizers alone for amending degraded soil. The synthetic chemical fertilizers are rapidly lost by either evaporation or by leaching in drainage water and it causes dangerous environmental pollution (Aisha *et al.*, 2007). Also, continuous usage of inorganic fertilizer affects soil structure and increases soil acidity. Hence, organic manures can serve as alternative to chemical fertilizers for improving soil fertility problems (Dauda *et al.*, 2007). Therefore, the incorporation and use of other plant nutrients sources such as cocoa pod husk, wood ash, oil palm bunch, refuse, brewery waste, droppings of poultry, cattle, sheep and goat dropping is expedient in the management of soil fertility for crop production (Ojeniyi et al 2007). Organic amendments became a positive alternative to inorganic amendments, due to their role in plant and soil health. The aim of this study is to evaluate the effect of organic and inorganic manure on growth and yield of tomatoes in Southern Guinea Savanna ecological zone.

MATERIALS AND METHODS

The trial was conducted at the Research Farm Faculty of Agriculture, Nasarawa State University, keffi, Shabu-Lafia Campus Nassarawa State in 2017 wet season. The area lies between latitude 080 33'N, longitude 080 33'E and at an altitude of 181.53m above sea level. The area falls under Koppens climatic classification of AW, that is tropical rainy climate with distinct dry season in winter. The rainy season span a period of seven months (April- October) with an annual rainfall of about 1200-2000mm. The daily maximum temperature ranges from 20.0ºC – 38.5ºC and daily minimum ranges from 18.7ºC – 28.2ºC. The months of February to early April are the months that have the highest maximum temperature while the lowest maximum temperature months are recorded in December and January because of the prevailing cold harmattan wind from the northern part of the country at this period. The relative humidity rises as from April to a maximum of about 75-90 percent in July (Jayeoba, 2013). The treatments consists of three levels of Poultry Manure (PM) (5, 10, and 15 tons/ha), three levels of each NPK (15: 15: 15) Fertilizer (integrated with Zinc) (200, 250 and 300kg/ha) and a mixture of the three levels of Poultry Manue and NPK Fertilizer (integrated with Zinc) (200kg/ha). Laid in a randomized complete block design (RCBD) and replicated three times. Soil sample was initial collected at a depth of 0-15cm with soil auger before incorporating poultry manure. Soil samples collected were bulked together, air-dried and gently crushed, then passed through 2mm sieve to

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obtain a homogeneous particle size, after which both physical and chemical properties of these samples were determined. The soil and poultry manure were collected separately and air-dried, then passed through 2 mm sieve mesh to obtain a homogeneous particle sizes, after which standard laboratory procedures as described by (Agbenin, 1995) were used for analysis of their chemical properties. Nursery beds were prepared using top soil and organic manure, then Dansirika tomato seeds were sown on the beds and other nursery practices were applied to raise up a vigorous growing seedlings of tomato for transplanting. The land was cleared, ridges were manually constructed before different rates of poultry manure incorporated and manures were allowed to cure for 2 weeks before transplanting. After 4 weeks in the nursery, the tomato seedlings were transplanted into the experimental field in June at a spacing of 70cm X 50cm. Weeding was done manually using small hoes at four weeks after transplanting (WAT) and supplementary weeding was also carried out through hand pulling before the maturity of the crops. The Tomato plants were sprayed against beetles and caterpillars, by applying Cyperforce which has both systemic and contact action, at the rate of 0.5 litres per hectare (30 mls per 15 litres of water) four times during plant growth period. Spraying starts from 3 WAT seedlings up to fruit formation and subsequently stopped before fruits maturation. The fruits were harvested when the colour started changing from green to red. Harvesting was done manually using hand from weekly to four-four days interval.

Crop Data Collection

Five plants were randomly sampled from each plot in the field and tagged for observation of growth parameter (number of leave, plant height and stem girth) and yield parameters ( ) of tomatoes. The amended soil and crop data collected were subjected to analysis of variance using GENSTAT (2008 Ed), and where there was a significant difference; the means were separated using F-LSD at 5% probability level

RESULTS AND DISCUSSION

Physical and Chemical Properties of the Soils of Lafia and Poultry manure

The soils before cropping were loamy sand (Table 1); low in nitrogen, phosphorus, potassium, organic carbon and also cation exchange capacity. The soil was acidic in nature with pH of 5.63, high in percent sand fraction (88.00) and also very high in percentage base saturation of 90.00% The poultry manure used in (Table 2) was very high in both organic matter 35.12%; nitrogen 2.81%; potassium 4.41%. While the pH was almost neutral (6.70) in poultry manure.

Effects of Poultry Manure, N.P.K Fertilizer integrated with Zinc on growth parameters of Tomato in Lafia, 2017 Wet Season

In table 3 application of poultry manure single, NPK and Zinc significantly ($p<0.05$) increased growth parameters (number of leaves, plant height and number of branches). Application of 15t/ha PM+200kg/ha NPK +Zn produced the highest number of tomato leaves (16.67, 24.33 and 33.33) at 2, 4 and 6 WAT. The control plots also produced the smallest number of tomato leaves (6.67, 10.33 and 14.00) at 2, 4 and 6 WAT compared to other rates. Application of 15t/ha PM+200kg/ha NPK +Zn produced the highest number of tomato leaves (16.67, 24.33 and 33.33) at 2, 4 and 6 WAT. The control plots also produced the smallest number of tomato leaves (6.67, 10.33 and 14.00) at 2, 4 and 6 WAT compared to other rates; application of 15t/ha PM+200kg/ha NPK +Zn produced the tallest tomato plants (34.25, 42.64 and 50.41cm) at 2, 4 and 6 WAT compared with other rates. Also, application of

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15t/ha PM+200kg/ha NPK +Zn produced the highest number of tomato branches (8.67, 10.67 and 11.33) at 2, 4 and 6 WAT. The control plots do not produced any branch at 2, 4 and 6 WAT.

Effects of Poultry Manure, N.P.K Fertilizer integrated with Zinc on Yield and Yield Parameter of Tomato at Lafia, 2017 Wet season

The result on table 4 showed that application of poultry manure single, NPK and Zinc significantly ($p<0.05$) increased number of tomato per plant, fruit diameter, number of fruits per plot and total yield per hectare of tomato. Application of 10t/haPM+200kg/ha NPK +Zn produced the highest number of tomato per plant (33.00); the widest fruit diameter (3.45cm) of tomato; highest fruits weight per plant of 603.70g and total yield of tomato (8.52 t/ha) were produced by application of 15t/haPM+200kg/ha NPK +Zn. This results is statistically similar with the application of 10t/haPM+200kg/ha NPK +Zn. The control plots recorded the lowest number of 6.00 tomato per plant, the smallest fruit diameter of 2.36cm, lowest fruits weight per plant of 79.20g and the smallest total yield of 1.13 t/ha of tomato.

DISCUSSION

The soil of the experimental site was low in most of the plant nutrient elements examined and slightly acidic (Table 1).This means that the soil was already exhausted due to intensive and continuous cultivation without adequate application of replenishment measures to sustain their productivity. Therefore, the vigorous growth performance of tomato exhibited by application of higher rates of poultry manure and NPK fertilizer + zinc could be attributed to the fact that the soil in the study area consist of higher quantity of sandy particles, low clay content and deficient in some macronutrient (Table 1). When poultry manure and NPK fertilizer + zinc were incorporated into the soil; Poultry manure and NPK fertilizer were able to improve the soil by the release of nutrients. Poultry manure application also brought about Reduction in the sizes of the soil pores thereby reducing leaching and increasing water holding capacity. There was generally soil structure improvement as a result of incorporation of this poultry manure; which encouraged the multiplication of soil micro-organisms. This explains why amending the soil with combination of organic and inorganic fertilizer brought about visible improvement in the growth performances of tomato. Also, there was a significant increase in yield of tomato as a result of application of organic and inorganic fertilizer. This increased in number of fruits and fruits yield per hectare could be attributed to the ability of Poultry manure and NPK + zinc to promote vigorous growth, increase meristematic and physiological activities in the plants due to supply of plant nutrient and improvement in the soil properties and increase nutrients uptake, thereby, resulting in the synthesis of more photo-assimilates, which is used in producing fruits. The better performance of the tomato plants with the highest rate of organic and NPK fertilizers is supported by the results of Ogundare et al. (2015) and Adekiya and Agbede (2014) who reported that maximum nutrient availability due to integrated use of organic and inorganic fertilizers increased nutrient uptake by the plant which in turn lead to dry matter production and tomato fruit yield. The above findings is confirmed by the result reported by Giwa (2004); when working on the combined application of pig manure and NPK fertilizer also increased tomato fruit yield compared with pig manure or NPK fertilizer treatments alone. Also, Adeniyan and Ojaniyi (2005) found that integrated application of poultry manure and NPK fertilizer increased maize yield compared with poultry manure or fertilizer applications alone.

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Conclusion

The result of the present study showed that the application of 15 t/h PM+200 kg/ha NPK +Zn greatly improved the growth and yield of tomato. However, the results obtained from this study was statistically similar with the results obtained when 10 t/ha PM+200 kg/ha NPK +Zn was applied.

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Table1: Physical and Chemical properties of soil at experimental site at 0-15cm depth

Soil Properties	**Lafia**
Physical properties	
Sand%	88
Silt%	3.4
Clay %	8.6
Textural class	Loamy Sand
Chemical properties	
pH in H_20	5.63
Organic carbon%	1.38
Organic matter%	2.37
Total nitrogen(gkg^{-1})	0.21
P (PPM)	3.01
Ca ($cmolkg^{-1}$)	3.48
Mg ($cmolkg^{-1}$)	2.63
K ($cmolkg^{-1}$)	0.25
Na ($cmolkg^{-1}$)	0.27
EA(cmolkg)	0.66
CEC ($cmolkg^{-1}$)	6.63
BS%	90

Table 2: Chemical Properties of Poultry manure

Chemical properties	**Poultry manure**
pH in H20	6.70
N (%)	2.81
P (%)	0.78
K (%)	4.41
Ca (%)	1.13
Mg (%)	0.51
Na (%)	0.31
C (%)	20.42
OM (%)	35.12

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Table 3: Effects of Poultry Manure, N.P.K Fertilizer integrated with Zinc on growth parameters of Tomato in Lafia, 2017 Wet Season

	Number of leaves			Plant height			Number of branches		
Treatment	2WAP	4WAP	6WAP	2WAP	4WAP	6WAP	2WAP	4WAP	6WAP
Control	6.67e	10.33f	14.00f	12.13g	15.97g	19.43h	0.00f	0.00f	0.00g
5t/ha PM	11.33d	21.00cd	30.00cd	28.57d	34.97e	37.97e	0.67f	1.33f	2.33f
10t/ha PM	11.33d	20.00d	28.33de	29.89c	35.88d	41.27d	1.33ef	3.00e	4.00e
15t/ha PM	13.33c	22.00bc	30.67bc	30.76c	36.53d	42.87d	2.67de	3.67e	5.67d
200kg/ha NPK +Zn	10.33d	18.00e	27.33e	20.97f	27.67f	33.37g	3.67d	6.00d	7.3o;3c
250kg/ha NPK +Zn	11.33d	20.00d	27.33e	21.10f	27.78f	34.97f	4.00d	7.00cd	7.667bc
300kg/ha NPK +Zn	12.67c	21.00cd	29.33cd	22.80e	27.06f	33.54g	5.67c	7.67cd	8.667b
5t/haPM+200kg/ha NPK +Zn	12.67c	21.00cd	29.00cd	32.67b	39.97c	45.93c	6.67bc	8.67bc	10.667a
10t/haPM+200kg/ha NPK +Zn	15.33b	23.33ab	31.33b	34.73a	41.06b	47.57b	8.00ab	9.67ab	11.000a
15t/ha PM+200kg/ha NPK +Zn	16.67a	24.33a	33.33a	34.25a	42.64a	50.43a	8.67a	10.67a	11.333a
SE ±	0.12	0.14	0.15	0.17	0.11	0.15	0.15	0.173	0.120

PM= Poultry Manure; N.P.K = NPK (15: 15 : 15) Integrated with Zinc

Table 4: Effects of Poultry Manure, N.P.K Fertilizer integrated with Zinc on Yield and Yield Parameter of tomato at Lafia, 2017 Wet season

Treatment	**No fruit Per plant**	**Fruit Dia(cm)**	**Yield (g/plot)**	**Yield (t/ha)**
Control	6.00e	2.36bc	79.20d	1.13d
5t/ha PM	19.00bcd	2.79abc	357.90c	5.11c
10t/ha PM	23.67abc	2.56bc	389.93c	5.57c
15t/ha PM	24.00abc	3.09abc	451.43bc	6.44bc
200kg/ha NPK +Zn	14.33cde	1.78bc	201.40d	2.87d
250kg/ha NPK +Zn	15.00cde	1.67c	209.53d	2.99d
300kg/ha NPK +Zn	11.67de	1.68c	209.57d	2.99d
5t/haPM+200kg/ha NPK +Zn	28.33ab	3.38ab	574.33ab	8.20ab
10t/haPM+200kg/ha NPK +Zn	33.00a	3.45ab	578.33ab	8.26ab
15t/ha PM+200kg/ha NPK +Zn	30.00a	4.35a	603.70a	8.62a
SE ±	0.94	0.16	14.18	0.20

PM= Poultry Manure; NPK = NPK (15: 15 :15) Integrated with Zinc

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Assessment of Micronutrient Fertility (Boron and Zinc) of the Soils of Bade LGA for Sustainable Vegetable Production

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Abstract
Plants need mineral elements in sufficient quantities for growth and metabolism. These elements may be needed in large or small quantities but all are functional in the plant metabolism and overall growth. This study was carried out to evaluate the Boron (B) and Zinc (Zn) status of the soils of Bade Local Government Area (LGA) of Yobe State, Nigeria, for sustainable vegetable production. The soils were randomly sampled from 10 farms within the LGA at the depths of 0-20, 20-40 and 40-60cm. Samples collected were then composite, based on depth and routine laboratory soil analysis were carried out. Results obtained showed that the soils of the area is sandy loam in texture with pH values slightly acidic (median of 6.5); while EC_{se} values indicated non-saline status (median value of 1.75dSm^{-1}). The median value for B was 0.33mg/kg, rated as low and deficient while, Zn^{2+} has a value of 0.98mg/kg which was rated as moderate and marginally sufficient. This indicated insufficiency and therefore best soil management practices that incorporate organic residues and manure with efficient use of inorganic fertilizers (that contains these micronutrients) are required for the soils of the study area.
*Keywords**:** Balanced Plant Nutrition,Boron, Zinc, Bade LGA, Yobe State*

INTRODUCTION

Micronutrients play an active role in the plant metabolic process from cell wall development to respiration, photosynthesis, chlorophyll formation, enzymes activity, nitrogen fixation etc (Ballabh et al., 2013). Intensive cropping, imbalanced fertilization and minimal usage of micronutrients and limited application of organic manures result in the depletion of soil fertility (Babaleshwar et al., 2017).

Micronutrients have an important role in balanced plant nutrition and stabilization of crop production. Their availability is influenced mainly by the soil properties, particularly pH, organic matter, soluble salts, cation exchange capacity and soil texture. Micronutrient deficiencies in soils get enhanced due to mining by the plants (Rattan and Sharma, 2004; Shukla, 2011).Because they are usually needed in small quantities are often neglected by the farmers and their external supply are usually less considered. The effect of micronutrients deficiencies may affect the yield and quality of most vegetables grown. While their importance is emphasized,their application must also be cautiously done and monitored to avoid over dosage that may lead to toxicities, which might restrict crop growth and ultimately reduce yield.

Micronutrient deficiencies are most likely to occur in sandy, low organic matter soils. High soil pH may also bring about micronutrient deficiencies, especially in sandy soils. Boron (B) are typically released through decomposition of organic residues and found mostly as anion BO_3^- in soil water which is easily leached in this form and Zinc (Zn^{++}) are found on the soil exchange or complexed with organic matter. Both boron and zinc are the most important micro-nutrients and essential for cell division, nitrogen and carbohydrate metabolism and water relation in plant growth(Brady and Weil, 2014).

Of all the micronutrients, Boron (B) is the only non-metal micronutrient most likely

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to be needed to supplement soil levels for vegetable production. Cauliflower, broccoli, cabbage and beets require application of additional B to avoid "hollow heart." Boron, copper, zinc and molybdenum have small ranges for optimum soil test values, which means the difference between deficient levels and toxic levels in the soil are small. Where soil B levels are less than 0.5 mg $kg^{-1,}$ deficiency is likely to occur for most crops. However, where levels are greater than about 5 mg kg^{-1}, toxicity may occur (Ryan *et al*., 2001). Soil and plant testing for diagnostic purposes have been employed in cropping systems where major nutrients (Nitrogen (N), Phosphorus (P) and Potassium (K)) deficiencies exist, but little research effort has been devoted to determine the role of micronutrients such as Boron (B) and Zinc (Zn) in vegetable crop production and productivity in the semi-arid regions of Nigeria. Inview of that, this research was aimed at assessing the current status of Boron and Zinc in the soils of Bade LGA to develop recommendations on thesemicronutrients fertility management.

MATERIALS AND METHOD

Study Area

The study was carried out in Bade Local Government Area (LGA) of Yobe State in the North Eastern part of Nigeria. The LGA covers an area of 77200 ha and the main crops grown are millet, sorghum, cowpea, sesame and vegetables. The climate is arid with an average rainfall of 450 mm/year (rainy period range from June to September). The potential average evapotranspiration is about 1400 mm/year. The soils are characterized by a sandy loam texture and the altitude varies from 334 to 377m (NPC, 2010; Alhassan *et al*., 2017).

Soil Sampling and Analysis

A total of 30 samples were collected for soil depth ranges of 0 – 20cm, 20 – 40cm and 40 – 60cm, that is 10 representative samples collected for each depth across the Local Government Area using soil auger during the month of November, 2016. The soil samples collected were then air dried and gently crushed using pistle and mortar and sieved through a 2mm sieve and packaged in a clean polyethylene bag before conducting laboratory analysis according to standard procedures.

Particle size distribution was carried out using hydrometer methodwhile, soil pH and electrical conductivity (EC) were measured in the supernatant suspension of a 1:1 soil:liquid mixture using pH meter and conductivity bridge respectively as outlined in Ryan *et al*. (2001).

Organic carbon was determined following the *Walkley-Black* procedure that involves a wet combustion of organic matter as described in van Reeuwijk (2002).

Boron was determined by Hot Water method while, Zinc was extracted by DTPA method and measured by Atomic Absorption Spectrophotometer (AAS) as described in Ryan *et al*. (2001).

DATA ANALYSIS

Data collected were subjected to descriptive analysisusing boxplots as simple graphical representations of a probability distribution with interquartile range (IQR) as a measure of statistical dispersion and variability using R (2017).

RESULTS AND DISCUSSION

Table 1 present results of some selected physical and chemical properties of the soils of Bade LGA. The selected properties did not showed any significant difference by depth.The particle size distributions of the soils indicated that the soils have relatively high sand content with a mean value of 623.40 g kg^{-1} and a mean clay content of 63.21g kg^{-1} giving the soils, a generally sandy loam texture across the measured soil depths. The soils are slightly acidic with median pH value of 6.45 and IQR (7.5 – 6.2). The electrical conductivity (EC) values (median = 0.13dSm^{-1}) was rated non-saline and a very low level of organic carbon content (median = 0.92gkg^{-1}) according to ratings reported in Ryan *et al.* (2001).

The boron level of the soils showed no significant difference in the B concentration by depth but they displayed varying distribution and a slight increase with depth (Figure 1). Generally the overall level of boron concentration in the soil showed an average median of 0.33mg kg^{-1} (IQR = 0.31 – 0.35 mg kg^{-1}) which is considered to be deficient (critical value of 0.45mg/kg was reported to be deficient level (Ryan et al., 2001).The low level of B in Bade Soils may be attributed to the factors that affect its availability as a near neutral pH of the soils, its solubilitywhich makes it readily leached in especially sandy soils with low organic matter content (Brady and Weil, 2017).Crops such as Cucumber, Onion, Pea, Sweet potato and Pepper that respondlowly to B can thrive well in such soils. While crops like Cabbage, Spinach and beet are highly responsive crops that will often require additions of B, if the nutrient concentration in the soil is low. Carrot, Lettuce, Radish, Sweetcorn and Tomato are medium responsive crops that may require monitoring of deficiency symptoms and amendment when necessary (Goldy, 2013; Johnson, 2015).

The results on zinc status of the soils of Bade LGA showed near similar median with wide variability of the zinc concentration at 0-20cm and 20-40cm soil depth (Figure, 2). The overall level of zinc concentration in the soil had an IQR of 0.95 – 1.03 mg kg^{-1}with an average median value of 0.98mg kg^{-1}. This result revealed that the contents of available Zn in thesesoils fell into the category of "marginal (0.6 - 1.2 mg kg^{-1})"based on the critical limits of Sharma *et al*.(2006) and Ryan *et al.* (2001).This Zn status would therefore require close monitoring/management to avoid deficiency and Zn fertilization for a better crop production. Deficiencies of Zn (low to marginal values) have also been reported in Northern Yobe State with values ranging between 0.55 to 1.05mg kg^{-1} by Mulima *et al*. (2015). The soil pH could be one of the contributing factors that cause the deficiency as reported by Schulte (2004) that Zn deficiency is limited to soils with pH above 6.5

CONCLUSION

This study showed that soils of Bade LGA are rated low to medium values inavailable Boron and Zinc respectively. The soils need close monitoring and application of fertilizers that contain B and Zn to remedy the deficiencies.While their applications are important, they must also be monitored to avoid over dosage that may lead to toxicities which will restrict crop growth and ultimately reduce yield.

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Table 1: Some selected physicochemical properties of the soils

Depth (cm)	Sand	Silt	Clay	Textural Class	pH (H_2O)	EC	OC
		g kg^{-1}				dSm^{-2}	g kg^{-1}
0 – 20	636.36	296.00	67.64	SL	6.65	0.27	0.96
20 – 40	626.73	311.73	61.54	SL	6.94	0.22	0.85
40 – 60	607.12	332.45	60.43	SL	6.70	0.34	0.88
K-W ($p \leq 0.05$)	0.097	0.067	0.435		0.188	0.798	0.435
Mean	623.40	313.39	63.21		6.76	0.28	0.90
Median	627.7	317.3	61.9		6.45	0.13	0.92
IQR	583 - 653.2	282.8 - 352.2	55.1-65.8		7.5-6.2	0.34-0.11	1.05-0.76

EC = Electrical conductivity, OC = Organic Carbon, K-W = Kruskal Wallis Test, IQR = Interquartile Range

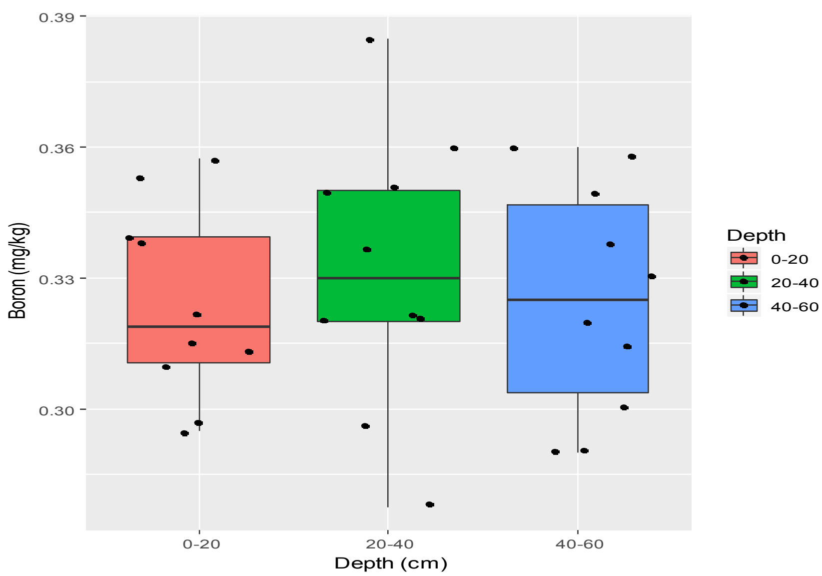

Figure 1: Boron (mg kg^{-1}) status of the soils of Bade LGA.

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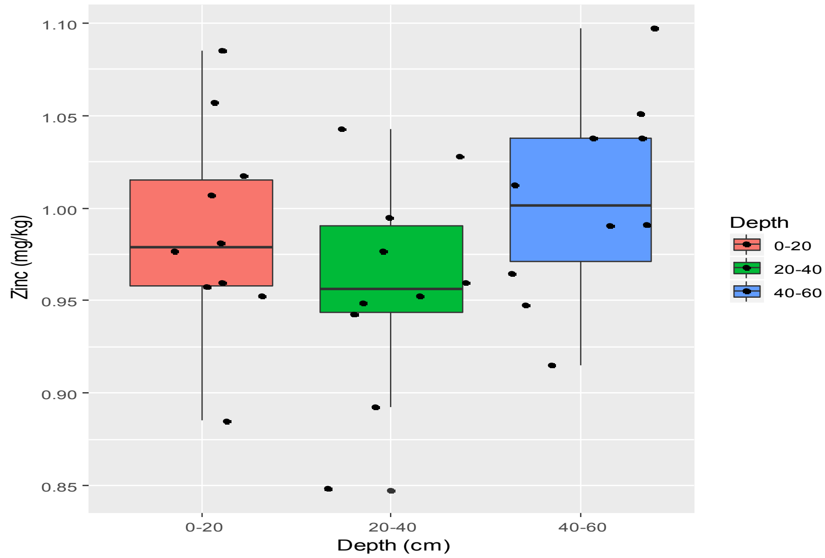

Figure 2: Zinc (mg kg^{-1}) status of the soils of Bade LGA.

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Capability Evaluation of Soils in Bakura, Zamfara State, Sudan Savannah, Nigeria

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Abstract
A detailed soil survey of 78.52ha land was conducted in LambarBakura to assess the soils for capability classification. Three soil mapping units were identified as; LBKR1, LBKR2, and LBKR3. The permanent soil limitations considered for the study were effective soil depth, drainage, texture and slope. The limitations were rated as; "Good" (class I), "Moderate" (class II) and "Marginal" (class III). Mapping unit LBKR3 was rated into Class 1 with no or minor limitation for very intensive cultivation, while LBKR1 and LBKR2 were rated class II with moderate limitations of slope (2-4%). Planting across the slope, cover cropping, use of crop residues and mulching were recommended to reduce surface runoff. These will boost crop production in these soils and promotes sustainability for future use.
Keywords: Capability Classification, evaluation, Land, Soil, Mapping units

INTRODUCTION

Land evaluation is viewed as the process of making predictions of land performance over time based on specific types of uses(Van Diepen*et al*. 1991; Rossiter, 1996). These predictions are then used as guides in strategic land use decision making.Land capability is the potential of land for use in either specified ways or with specified management practices (Dent and Young, 1981). It has been used in a number of land classification systems notably that of the Soil Conservation Service of United State Department of Agriculture (USDA) (Killingerbeil and Montgomery, 1961). Capability classification refers to general kinds of land use (similar to FAO frame work), rather than specific land use systems (FAO, land utilization types), for which suitability of land areas refers to. Thus, detailed explanations about land use and management are not captured in capability classification (Rossiter, 1994).In capability evaluation, rating is based on permanent soil characteristics (limitations) with regard to risks of soil damage (FDLAR, 2013). Limitations are land characteristics which have an adverse effect on capability. Most of the factors considered for capability evaluation are those that relates to soil physical conditions; like effective rooting depth, coarse fragments, drainage conditions, topography (which can predispose the soil to erosion and or flooding), and climatic condition of rainfall (Dent and Young, 1981, Rossiter, 1995).

Many researchers have demonstrated the relevance of land capability classification in allocating land uses that aid sustainability. This includes the workof Ali *et al*.(2009) in El Hamman District in Egypt, where slope, effective depth, drainage, texture, clay, permeability, CEC, EC, ESP, and $CaCO_3$ content were considered as limitations and classified the soils into capability class IV and V. Similarly, Ali and Kotb (2010), used satellite data and GIS adjacent to El Manzala in Egypt and classified the soils into classI (highly capable), class II (moderately capable), class III (low capable) and class IV (very low capable). Attribute land characteristics used as limitations include; $CaCO_3$ content, textural class, soil depth, salinity, alkalinity, CEC and drainage conditions. However, Raji (2004), in Kano River Project; considered slope, soil depth,

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drainage, topography, texture and climatic condition as limitations. He classified the soils in to capability class I, II and III as good, moderate and marginal respectively. The FDALR (2013) in a semi detailed soil survey of some selected states in south western Nigeria reported a capability class of III with major limitations of low subsurface CEC, coarse fragments (gravels), as well as susceptibility to erosion in some areas. In a similar report, some soils were classified as capability class IIIsw with limitations of soil texture and wetness in some selected states of North Central Nigeria. Poor soil baseline data has been identified as one of the major reasons leading to inappropriate land use. Land capability evaluation will therefore help in allocating land to its appropriate use there by aiding sustainability. The objective of this work is therefore to assess the LambarBakura soils using land capability evaluation.

MATERIALS AND METHODS

Description of the Project Area

The study site is located in LambarBakura,Bakura Local Government Area, Zamfara state. The site is located on western part of Bakura, Sokoto road. The survey area covered an area of 78.52ha. Geographically, the study area is located between N12^o 35\`38\`\`.0, E005$^o$ 54\`12.8\`\`and N12^o 35\`07.5\`\` E005$^o$ 53\`13.7\`\`. Geologically, Zamfara state is characterized by very old igneous and metamorphic rocks formed during the Precambrian paleo state era. In general, the relief bears the relationship to its geology. The general elevation of the land ranges from 244m to 366m above se sea level (Swindel*et al.*, 1982).The Climate is sudano-sahelian climate, with hottest months from March and April. The peak of the rainy season ranges from July to September. But TalataMafara and Bakurarecords 798mm of rainfall. The onset of the rains on the average is between mid-march and May, lasting for about six months. The maximum and minimum annual temperatures are 34^{o}C and 16 ^{o}C.The vegetation in Bakura consists of Sudan and Northern Guinea Savannah. It is characterized by wood lands, where grasses occur either totally or mixed with other herbaceous shrubby plant. The main crops under cultivation are millet, sorghum, cowpea, groundnut and cotton. The major soil type in Bakura area is the ferruginous soils characterized by a sandy surface horizon with a clayey subsurface both of which are fertile for agricultural production. They are susceptible to erosion since the top soil is easily washed off by rain water, especially if the vegetation cover is removed.

Field work

A conventional method of soil survey involving the free rigid grid procedure was adopted for the survey. Baselines covering the entire length of the survey area were cut for the field survey. Appropriately labeled traverses were then cut at right angles at 100m intervals to the baselines. The traverses were later pegged at 100m intervals for the purpose of systematic auger observations along each traverse using Geographical Positioning System (GPS). At each auger point, auger borings were made to a depth of 120 cm or where an impenetrable layer was encountered. Soil descriptions were made at 25 cm depth intervals or according to horizon sequences, where possible. At each auger-point, a full range of environmental conditions and selected soil morphological characteristics like soil depth, colour, structure, texture and consistenc were recorded. The base map was refined on the field by classifying and plotting the information gathered from soil landscape, auger borings and site characteristics from the sample areas. Soil mapping units corresponding to auger-point locations were plotted along the traverses on the base map for the survey area at a scale of 1:9000. On the basis of

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theauger-point plotting, approximate soil boundaries were drawn to fix soil mapping unit polygons. Points of transition within and between traverses for the soil mapping units were checked to ensure accuracy of the soil boundary lines. A total of three soil mapping units were identified and delineated as Lambar Bakura1 (LBKR 1), LambarBakura 2 (LBKR 2) and LambarBakura 3 (LBKR 3). In the entire major soil mapping units, two profile pits were dug in LBKR1 and LBKR3, while three profile pits were dug in LBKR 2, making a total of seven profile pits. The soils were described and sampled according to their natural horizons. The description of the morphological properties followed the pattern of USDA (soil survey staff, 1999, 2010) and FAO (1990).

Soil samplingand laboratory studies

Following the description of the morphological properties of the soil profile pits (Soil Science Division Staff, 2017), soil samples were collected for laboratory analyses. Bulk (disturbed) soil samples were taken from the genetic horizons of the profile pits into plastic bags and labeled. These were taken to the laboratory for the determination of relevant physical properties.

The disturbed soil samples collected from soil profile pits were air dried ground and sieved to remove materials larger than 2mm. The less than 2mm was used for the determination of Particle size distribution as described by Gee and Or (2002).The capability classification used was based on rating of a set of permanent soil characteristics as regards to risks of soil damage (Ya'u, 2015). The permanent soil limitations considered were soil depth, drainage, texture, slope and climate. These were rated to form a simple capability classification in accordance with the main limiting factor as good, moderate and marginal (FAO, 1985; Raji, 2004).

RESULTS AND DISCUSSION

Morphological and physical properties.

The permanent soil limitations of soil depth, drainage, textureand slope were discussed based on the delineated soil mapping units. The LBKR1 mapping unit was moderately deep and well drained (Table 2). The soils were developed in sedimentary material over sandstone. The surface soils ranged from 20 to 40 cm in thickness of strong red to yellowish red (5YR5/8 moist) colours and of sandy loam to sandy clay loam textures. The subsoil colours ranged from red to yellowish red (5YR4/6 moist), while texture was dominantly gravelly sandy clay loam to sandy clay loam. The soil unit occupied mid-slope position of nearly level to level landscape position with dominant gradient of 0-2%. The soils were weakly structured. In the surface horizon, the soils were slightly sticky when wet, friable when moist, and hard when dry. However, in the subsurface, the soils were sticky when wet, firm when moist and hard when dry. Most of the boundaries were gradual and smooth. Sand was the dominant particle-size fraction in the surface and subsurface soils. The sand fraction ranged from 700 to 840 gkg^{-1} in the surface and 620 to 680 gkg^{-1}in the subsurface soils. Silt was the least of the three fractions. The soil was therefore, mainly sandy loam in the surface and sandy clay loam in the subsurface horizons.

The LBKR 2 soil mapping unit was deep to very deep and well drained. The soils were developed in sedimentary material over sandstone. The surface soils ranged from yellowish red to strong brown ((7.5YR4/6 moist) in colour and of sandy loam to sandy clay loam textures. The subsoil colours ranged from yellowish red to yellowish brown (10YR5/8 moist), while texture was dominantly sandy clay loam. The soil unit occupied mid-slope position of nearly level to level landscape position with dominant gradient of 0-2%.

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The soils were weakly structured in the surface horizons which were attributed to the dominance of sand fractions. There were few pores and very fine roots. In the surface horizon, the soils were slightly sticky when wet, friable when moist, and hard when dry. However, in the subsurface, the soils ranged from non-sticky to slightly sticky when wet, firm when moist and hard when dry. Most of the boundaries ranged from gradual and smooth to diffuse and wavy.

Sand was the dominant particle-size fraction in the surface and subsurface soils. The sand fraction ranged from 540 to 780 gkg^{-1} in the surface and subsurface respectively and decreases with an increase in soil depth. Silt was the least of the three fractions and its value remain constant with depth. The clay fraction ranged from 120 to 280 gkg^{-1}. The soil was therefore, mainly sandy loam in the surface and sandy clay loam in the subsurface horizons.

Soil mapping unit LBKR 3 occupies nearly level (2 – 4%) on upper slope position in the landscape. The soils were shallow to moderately deep and well drained and developed in sedimentary material over sandstone. The surface soil is strong brown to yellowish red (15YR 5/6, moist) colour over red to very pale brown (10YR 7/4) subsoil. The surface soils had weak sub angular blocky structure over sub angular blocky structure to gravelly sandy subsoil horizons. Their consistence is slightly sticky and slightly plastic surface over non sticky and non-plastic subsoil. The soils of this mapping unit had some slight sheet erosion. Sand was still the dominant particle size with values ranging from 660 to 820 g kg^{-1} and the distribution pattern within the profile was irregular. Silt varied between 60 and 160 gkg^{-1} and the values decreases with an increase in soil depth. Clay content ranges between 100 and 180 gkg^{-1}, and the distribution was also irregular. The soil was therefore, mainly sandy loam in the surface and gravelly sandy loam in the subsurface horizons.

Land capability classification

Land capability class I

In this capability class were the soils of mapping unit LBKR1 and LBKR2. These are well drained soils that are moderately deep to very deep with good medium for easy root development and easy mechanization with slopes of 0-2%. The LambarBakura soils were generally associated with climatic limitations, because of the critically low and poorly distributed rainfall, which is inadequate for some crops. Class I soils were rated “Good” with few limitations for intensive cultivation, and can be usedfor wide variety of crops, pasture, woodland and wildlife reserves (Killingerbeil and Montgomery, 1961).

Land capability class II

These are soils that are well drained, deep with good medium for easy root penetration and mechanization. The soils however had slopes between 2-4% which makes them liable to sheet erosion and weakly structured. They are therefore “moderately capable” with moderate limitations that reduce the choice of plants or require moderate conservation practices. The major limitation against successful crop production is theslight erosion hazard. Contour farming, Cover cropping in a good rotation farming system will boost crop production in these soils. Use of crop/plant residues as mulching materials will also reduce surface runoff. The soil mapping units that falls under this class was LBKR3.

CONCLUSION

The soils of LBKR1 and LBKR2 were classified as “Good”with minor or no limitation, while mapping unit LBKR1 and LBKR2 were classified as “moderate” with slight erosion hazards as moderate limitation. These limitations could be corrected to upgrade the “moderate” class to "good" class by use of cover crops in a good rotation system, planting across the slope and use of crop/plant residues as mulching materials to reduce surface runoffs.

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Table 1:Main limiting land characteristics of the study area

Map unit	Pedon	Relevant land characteristics			
		Effective depth (cm)	**Drainage**	**Texture**	**Slope (%)**
LBKR1	1	130	Well drained	LS, SCL	0-2
	2	130	Well drained	SL, SCL	0-2
LBKR2	1	130	Well drained	SL, SCL	0-2
	2	140	Well drained	SL,SCL	0-2
	3	155	Well drained	SL, SCL	0-2
LBKR3	1	112	Well drained	SL	2-3
	2	118	Well drained	SL, SCL	2-4

LS=Loamy sand , SCL= Sandy clay loam, SL= Sandy loam

Table 2: Legend for land capability classification

Soil characteristics	Class I Good	Class II Moderate	Class III Marginal
Soil depth (cm)	120	50-120	50
Drainage	Well drained	Moderately, imperfectly drained	Poorly drained
Slope (%)	0-2	2-4	4
Texture	Loam	Sandy loam to silty clay loam	Loamy sand to clay loam

(FAO, 1985; Raji, 2004)

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Comparative Analysis of Performance of Tomato Production Using Different selected Soil Amendment Materialsat National Horticultural Research Institute Mbato Out-Station Okigwe, Imo State, Nigeria.

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Abstract
The study was conducted on Performance of Tomato Production Using Different selected Soil Amendment Materials at National Horticultural Research Institute Mbato Out-Station Okigwe between 2015 and 2016. The soil amendment materials used were incorporated into the soil one month before planting include irvingiapeeIs (Irv), empty palm bunch (Epb) and Poultry manure (Pm) at100g/plant, 200g/plant and 300g/plant translating into 3.3t/ha, 6.6t/ha and 9.9t/ha respectively. Seedlings in the nursery were after five (5) weeks transplanted at 60cm x 50cm on the beds giving 33,333plants per hectare. Dead seedlings were replaced accordingly. N.P.K fertilizer were applied at two weeks after transplanting at 150g/plant; giving about 50kg/ha. Plots were manually weeded, taking of growth and yield parameters were carried at three weeks intervals, data obtained were subjected to ANOVA and gross margin analysis. Result showed that plots treated with poultry manure at 9.9t/ha and plots treated with about 50kg/ha NPK recorded highest values of 65.9cm and 70.2cm, 65.6cm and 59.6cm for plant height and canopy spread respectively, at12 weeks After Transplanting, (WAT). Tomato plots treated with poultry manure (Pm_3) at 9.9t/ha recorded highest average yield of 22 fruits per plant and was closely followed by average yield of 18.2 fruits /plant recorded from plots treated with NPK 50kg/ha. The least, mean of 4 fruits / plant was recorded from the control plots. Meanwhile, plots treated with poultry manure at 9.9tons/ha gave the highest yield of 37,664(kg)/ha of tomatoes and consequently, highest revenue of ₦6, 056,580.00, this is closely followed by plots treated with NPK at 50tons/ha, which yielded 29,702.4kg/ha of tomatoes and revenue of ₦5,049,408.00.

Key words; *tomatoes production, irvingia peels, empty palm bunch, poultry manure, NPK.*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is a well known vegetable in most parts of the world due to its nutritional and medicinal values. And it can be taken fresh or in various processed forms because of its numerous nutrient content and hence widespread production (Kumer*etal*, 2013). Ripe tomato is a good source of minerals and vitamins, particularly vitamin 'C' and carotenoids, which are eaten all over the world in the form of fresh or in processed form. Regular eating of tomato helps to prevent several diseases (Willcox*etal*,2003, Sharoni and Levi,2006) maybe because of the presence of antioxidants including carotenes, (Lycopene and β-carotene), ascorbic acid, and phenolic compounds. Consumption of tomato is very essential for neutralizing the acids produced during the process of digestion of meat and other fatty acids (Smith, 1994).Tomato gives important roughage which stimulates digestion and helps to reduce constipation Parray et al(2007). It is a valuable source of carbohydrates, fats, proteins, vitamins and minerals which when eaten makes the eye looking brighter than using cosmetics on it (Gojale, 2002).Thus, tomato is a vital ingredient in the food of Africans including Nigerians. Tomato seeds contain 24% oil, and also of great medicinal value. According to Parray*et al* (2007), consumption of tomato and its seeds enhance gastric secretion, act as blood purifier and keep intestines in good condition. Commercial production of tomato has great potential for improving standard of living through increased income, generation of employment opportunities and enhanced better nutrition

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intake (Calkins, 1978). Commercial tomato production abounds in the northern Savannah zone of Nigeria, where better yield is obtained, maybe because of low rainfall pattern in the area (Bodunde, *et al.,* 1996). And in Nigeria, generally, the production quantity was 1.8 metric million tons per annum (This day, 2017). However, decreasing soil fertility and increasing cost of inputs, particularly fertilizer and organic manure as well as incidence of pests and diseases, has affected tomato production in Nigeria, resulting in reduced yields (Ogunwole,*et al.,*2006). This could be attributed to the fact that most tropical soils are deeply weathered and leached due to heavy rainfall pattern and continuous cropping system coupled with the use of bush burning method of land clearing which destroys plant residues and soil nutrients (Onwueremadu *et al., 2008*). That is, lack of adequate crops' yield including tomato, in Nigeria are associated with lack of adequate nitrogen, N and phosphorus, P which mainly, due to exhaustion of soil N as a result of continuous farming Ojeniyi,(2010).This situation of low soil fertility status prompted the need for soil amendment. And soil amendment has yielded positive results in both growth and yield of crops including tomato over the years; also, it improves physical, chemical and biological properties of the soil. In addition to increasing soil Nitrogen, the soil organic matter is protected. Moreover, the potentials of using organic manure such as irvingia peels, dried empty palm bunch, poultry manure and fertilizer N.P.K. 20.10.10 as soil amendment materials for tomato production has not been well known in the area, so there is scarcity of research data on them especially in Mbato-Okigwe area of Imo State, Nigeria.

MATERIALS AND METHODS

The experiment was conducted at National Horticultural Research Institute (NIHORT) Mbato out-station Okigwe, Imo state, Nigeria, in 2015 between October and December using borehole water as source of irrigation. In 2016 the experiment was repeated from April to July and it failed maybe because of heavy rainfall in the area. Between August and November 2016, the experiment was carried out again and it was successful. Seeds of Roma V.F variety were sown in the nursery and Cured Irvingia peels (Irv), empty palm bunch (Epb), and Poultry manure (Pm) are the organic soil amendment materials used at three rates, a control and a 50kg/ha N.P.K dose were the treatments. Plots were marked and made into beds of 3m x 2m dimensions, one meter gap between beds and 2 meters gap between replications. The experiment was laid out in an RCBD with three replications. Two weeks before transplanting, the organic soil amendment materials were incorporated into the soil as follows; Irvingia peels(Irv), empty palm bunch (Epb) and Poultry manure (Pm) at100g/plant, 200g/plant and 300g/plant translating into 3.3t/ha, 6.6t/ha and 9.9t/ha respectively. Seedlings in the nursery were after five (5) weeks transplanted at 60cm x 50cm on the beds giving 33,333 plants/ha And dead seedlings were replaced accordingly.NPK fertilizer were applied at two weeks after transplanting at 150g/plant; giving about 50kg/ha. Hand weeding and growth parameters were taken at three weeks interval. Data obtained were subjected to ANOVA, and gross margin, while means were separated using LSD at 5% levels.

RESULTS AND DISCUSSION

Analysis of data in Table 1 shows that the growth parameters increased marginally after 3 weeks with increase in the soil amendments applied when compared with the control, since, their values ranged between 6cm and 8cm, 7cm and 9cm, 7

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and 8 and 0.2cm and 0.4cm for plant heights, canopy spreads, number of leaves and stem girth respectively. Nevertheless, at 6 WAT, Poultry manure (Pm_1) at 3.3ton /ha and NPK at 49.9kg/ha recorded 20cm and 25cm for plant heights,24cm and 17cm for canopy spreads, and 6 and 9 for number of leaves as well as 0.4cm each for stem girth, while Irvingia peels (Irv_1) at 3.3ton /ha and empty palm bunch (epb_1) at 3.3ton/ha had recorded 16cm each, for plant height,16cm and 15cm for canopy spreads, 6 each, for number of leaves, 0.4cm and 0.38cm for stem girth respectively, meanwhile, at 9WAT, Days to 50% flowering was early on the control at 87 Days (45 Days after transplanting), maybe because of lack of adequate available soil nutrients for the crops, and late at 93 Days (51 Days after transplanting) for plots treated with poultry manure(Pm_3) at 9.9ton/ha. AndKumar *et al.,(*2013) had reported 49 Days for Azad T-6, which is close to Iwollo local at 41 Days and Roma VF at 45-67 Days as reported by Ugwuanyi*et. al*.(2016). Thus, plots treated with poultry manure at 9.9ton /ha and plots treated with 49.9kg/ha NPK recorded highest values of growth parameters at 65.9cm and 70.2cm, and 65.6cm and 59.6cm for plant height and canopy spread respectively, this is closely followed by 62cm and 65cm values for plant height and canopy spread from plots treated with poultry manure at 6.6ton/ha. The least plant height and canopy spread values were 50cm and 49cm for 3.3ton/ha Irvingia peels, 44cm and 47cm for 3.3ton/ha empty palm bunch treated plots. Table 2 showed that tomato plots treated with poultry manure (Pm_3) at 9.9ton/ha recorded highest average yield of 22 fruits per plant and was followed by average yield of 18.2 fruits /plant recorded from plots treated with NPK 49.9kg/ha, Kesitu and Heri (2014) reported means of 22.00 fruits/plant fortangya tomato variety. The least, means of 4 fruits / plant was recorded from the control plots. Similarly, yield was also low by average of 6 fruits/per plant recorded for each of plots treated with Irvingia peels (Irv_1) and empty palm bunch (ePb_1) at3.3 ton/ha. Plots treated with 6.6 ton/ha of poultry manure recorded mean of14.0 fruits/plant which is similar to average yield of14.83 fruits/plant for Roma VF reported by Ugwuanyi*et.al.* (2016). Fruit lengths were highest at 5.5cm and 5.0cm and fruit breadths at 3.8cm and 3.7cm from plots treated with poultry manure (Pm_3) at 9.9ton/ha and NPK at 49.9kg/ha .Fruit lengths were least at 3.9cm and 4 cm from the control and plots treated with empty palm bunch(epb_1) at 3.3ton/ha . Fruit breadths were least at 2.4cm and 3cm from the control and plots treated with Irvingia peel(lrv_1) at 3.3ton/ha.

Table 3 showed total output of 29,702.4kg of tomatoes, from NPK hectare, with total variable cost of ₦253,900.00,which have generated ₦5,049,408.00, as revenue, giving a gross margin of ₦ 4,795,508.00 and a return of .05k on every ₦1invested in tomatoes production in the area, this bumper harvest from NPK hectare could be strongly associated with timely availability of both macro and micro elements from the fertilizer to the crop and so, this result tallies with the findings of Isa *et al*,2014 and Nafiu*et al,* 2011 who reported that application of NPK fertilizer enhances growth and yield of tomatoes, which might be due to the availability of essential elements from inorganic fertilizer used. While, outputs of 4,656(kg), 7,784(kg) and 11,264(kg) of tomatoes were recorded from hectares treated with Invirgia peels, at 3.3tons, 6.6tons and 9.9tons, which have incurred total variable costs of ₦263,050, ₦ 279,700 and ₦296,350 each, and have given total revenues of ₦791,520, ₦1,323,280 and ₦1,914,880, respectively, with gross margins of ₦528,470, ₦1,043,580 and ₦1,618,530,indicating returns of 0.5k,

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0.3k, and 0.2k on every ₦1 invested in tomatoes production from each hectare, this result is similar to the findings of Blay *et al.* (2001), who reported that the application of organic fertilizers such as invirgia peels to the soil supply plant nutrients for increased plant height, more leaves and increased yield.

Again, empty palm bunch treated hectares at 3.3tons, 6.6tons and 9.9tons recorded total outputs of 4,704(kg), 7,168(kg) and 8,456(kg) of tomatoes each, with total variable costs of ₦263,050, ₦ 279,700 and ₦296,350, while, total revenues of₦799,680.00, ₦1,218,560.00 and ₦1,437,520.00 were obtained,and gross margins of ₦536,630.00, ₦938,860.00 and ₦1,141,170.00 were recorded respectively, also, returns of 0.5k, 0.3k and 0.26k on every ₦1 invested in tomatoes production from each hectare were made, thus, empty palm bunch has potential in improving the growth, fruit yield and nutritional contents of any tomato varieties Ilupeju, *et al*, (2015), however, the low yield obtained when compared with other treatment used could be strongly associated with low degradation rate of empty palm bunch, may be because of presence of hemicelluloses and lignin which are hard biodegradable substances (Wathida*et al.,*2011) and these significantly impaired the timely release of nutrients to the crop,finally, hectares treated with poultry manure at 3.3tons, 6.6tons and 9.9tons yielded 11,808(kg), 21,056(kg) and 37,664(kg) of tomatoes each , which incurred total variable costs of ₦279,700 , ₦313,000 and ₦346,300 each, total revenues of ₦2,007,360, ₦3,579,520 and ₦6,402,880 were generated, while gross margins were ₦1,727,660, ₦3,266,520 and ₦6,056,580.00 and returns of 0.2k, 0.1k and 0.06k in every ₦1 invested were got in each hectare, in the area, this result implies that good rate of poultry manure significantly enhances tomatoes yield, which conforms with the reports of Agbede*et al*, (2015) that tomatoes performed best under good rate of poultry manure application and it was likely that its mineralization process and therefore the release of nutrients coincided with the feeding rate of tomatoes.

CONCLUSION AND RECOMMENDATION

Tomato plots treated with poultry manure at 9.9ton /ha and plots treated with 49.9kg/ha NPK recorded highest values of growth parameters and yield, consequently, they generated highest income. Control plots recorded least growth parameters and income. Also, growth parameters and yield was low from each of plots treated with Irvingia peels (Irv_1) and empty palm bunch (ePb_1) at3.3 ton/ha. Thus, it is therefore recommended that poultry manure at a good rate of 10tons/hectare or NPK fertilizer at 50kg/ha should be used in tomatoes production for increased output.

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Table 1: Growth Parameters at 3wat, 6wat, 9wat and 12wat

S/NO	Treatments	Plant Height (cm)	Canopy spread(cm)	Number of leaves	Stem Girth (cm)	Days to 50% flowerings
1	Control	7 , 15, 39, 42.5	8, 14, 32, 41.10	5, 6, 8, 16	0.25, 0.3, 0.6, 0.8	87
2	NPK	9, 25, 57, 65.6	10, 24, 59.6, 65	8, 9, 18, 28	0.5, 0.4, 0.8, 1.3	92
3	Irv_1	8, 16, 44.6, 50.0	9,16, 46.10, 49	7, 6, 9, 14.1	0.4, 0.4, 0.76, 1.0	89
4	Irv_2	7, 17, 48.5, 53.5	9, 22, 45.3, 55	7,6, 12, 15	0.4, 0.37, 0.7, 1.0	90
5	Irv_3	8, 21, 50.0, 58.0	10, 23, 48, 57	8, 8, 13, 17	0.3, 0 .4,0.75, 1.2	91
6	ePb_1	7, 16, 44.1, 47.1	8, 15, 42, 47.0	6, 6, 11, 13.8	0.3,0.38, 0.71, 0.9	89
7	ePb_2	8, 19, 49.0, 49.5	8,18, 47, 50.0	7, 7, 14, 15	0.4, 0.4, 0.8, 1.0	90
8	ePb_3	8, 23, 51.2, 54.0	9, 21, 50.5, 52.0	8, 7, 15, 18	0.4, 0.35, 0.7, 1.2	90
9	Pm_1	7, 20, 48.0, 55.0	7,17, 44, 56.0	7, 6, 12, 17	0.4, 0.4,0.65, 1.0	90
10	Pm_2	9, 26, 52.0, 62.0	10, 19, 48, 65	7, 8, 13, 20	0.4, 0.4, 0.7, 1.2	88
11	Pm_3	12, 29, 61.0, 68.9	11, 22, 67, 70.2	8, 9, 19, 31	0.5, 0.5, 0.8, 1.4	90
LSD		Ns, 11.5, 21.2, 23.3	Ns,10.6,26.4,27.3	Ns, 2.4, 5.5, 6.1	Ns, 0.1, 0.3, 0.7	3.9

Source; field data analysis, 2017. WAT= Weeks After Transplanting

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Table 2:**Analysis ofTomatoes Yield at NIHORT Mbato**

S/NO	Treatments	No. Of fruits/plant	No of fruits per hectare	Fruit wt. per plant (g)	Fruit wt per hectare (kg)	Lengths of fruits (cm)	Breadths of fruits (cm)
1	Control	4	160,000	68.8	2,752	3.9	2.9
2	NPK	18.2	728,000	742.56	29,702.4	5.4	3.7
3	Irv_1	6.0	240,000	116.40	4,656.0	4.2	3.1
4	Irv_2	7.0	280,000	194.60	7,784	4.7	3.4
5	Irv_3	8.0	320,000	281.60	11,264	5.1	3.5
6	ePb_1	6.0	240,000	117.60	4,704	4.1	3.1
7	ePb_2	7.0	280,000	179.20	7,168	4.8	3.3
8	ePb_3	7.0	280,000	211.40	8,456	5.0	3.5
9	Pm_1	9.0	360,000	295.20	11,808	4.9	3.2
10	Pm_2	14.0	560,000	526.40	21,056	5.2	3.6
11	Pm_3	22.0	800,000	941.60	37,664	5.5	3.8
LSD		5.6	230,000	97.6	2117	1.3	1.1

Source; field data analysis, 2017

Table3: Estimate of Cost and Returns of tomato production at NIHORT Mbato

Items	**Unit value (₦)**	**Average quantity/hectare**	**Total value (₦)/hectare**
Variable cost			
Seeds(kg)	13,000	1	13,000
hiring of tractor and land preparation	15,000	1	15,000
Labour(mandays)	1,200	25	30,000
Herbicides(litres) round up	2,400	1	2,400
Pesticides(kg)copper hydroxide	6,000	1	6,000
Empty baskets	300	460	138,000
Transport	-	-	30,000
Farm security	-	-	12,000
Sub-total variable cost			₦246,400
Cost of Treatments used:			
Fertilizer (NPK) at 50kg/ha	150	50	7,500
Invirgia peel$_1$ (Irv_1) (kg) at 3.33ton/ha	5	3,330	16,650
Invirgia peel$_2$(Irv_2) (kg) at 6.66ton/ha	5	6,660	33,300
Invirgia peel$_3$ (Irv_3) (kg) at 9.99ton/ha	5	9,990	49,950
Empty palm bunch$_1$(epb_1)(kg) at 3.33ton/ha	5	3,330	16,650
Empty palm bunch$_2$(epb_2)(kg) at 6.66ton/ha	5	6,660	33,300
Empty palm bunch$_3$ (epb_3) (kg) at 9.99ton/ha	5	9,990	49,950
Poultry manure$_1$(pm_1)(kg) at 3.33ton/ha	10	3,330	33,300
Poultry manure$_2$ (pm_2) (kg) at 6.66ton/ha	10	6,660	66,600
Poultry manure$_3$ (pm_3) (kg) at 9.99ton/ha	10	9,990	99,900
Total variable costs (TVC)/ha with NPK			₦253,900
Total variable costs (TVC)/ha with Irv_1			₦263,050
Total variable costs (TVC)/ha with Irv_2			₦ 279,700
Total variable costs (TVC)/ha with Irv_3			₦296,350
Total variable costs (TVC)/ha with epb_1			₦263,050
Total variable costs (TVC)/ha with epb_2			₦ 279,700

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Total variable costs (TVC)/ha with epb_3	₦296,350
Total variable costs (TVC)/ha with pm_1	₦279,700
Total variable costs (TVC)/ha with pm_2	₦313,000
Total variable costs (TVC)/ha with pm_3	₦346,300
Total variable costs (TVC)/ha with control	₦246,400
Output/ha with NPK	29,702.4(kg)
Output/ha with Irv_1	4,656(kg)
Output/ha with Irv_2	7,784(kg)
Output/ha with Irv_3	11,264(kg)
Output/ha with epb_1	4,704(kg)
Output/ha with epb_2	7,168(kg)
Output/ha with epb_3	8,456(kg)
Output/ha with pm_1	11,808(kg)
Output/ha with pm_2	21,056(kg)
Output/ha with pm_3	37,664(kg)
Cost of tomatoes=₦170/kg or ₦10,000/65kg basket	

Source, field data analysis, 2017

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Composting methods, temperatures changes and microbial population at different composting stages

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Abstract
Composting generally involve the action of heat and microorganisms on organic materials. This study was carried out at the Floriculture garden of National horticultural research institute, Ibadan, to investigate the effect of different methods of composting of the density of microorganism present. Pot and Pit composting methods were used for this experiment. The composting material consisted of cassava peel and poultry manure at ratio 2:1 on dry weight basis. Microbial analysis of compost was determined at intervals; 4, 12 and 24 weeks of composting and this corresponds to mesophilic, thermophilic and curing or maturity stages. Serial dilutions of 10^{-3} and 10^{-5} were prepared by sequentially transferring 1 ml sample into another test tube containing 9 ml sterile distilled water. Plates were incubated at 28±2°C for 24 hrs (for bacteria) and 48 hrs (for fungi). Compost microbial colonies were counted and recorded. From the results, high heat was generated in the pit and drum methods of composting compared with ambient method, with the highest record of 63°C for pit method. At thermophilic stage bacterial cfu/g was significantly ($P<0.05$) higher (7.4×10^5 cfu/g) compared with fungi population (4.8×10^5 cfu/g). Similar trend was observed at maturity stage where bacteria population was significantly ($P<0.05$) higher. There was no significant difference in the microbial density of the different composting methods at both mesophillic and maturing stages respectively. However, there was a significant ($P<0.05$) different in the thermophilic stage with the highest record (9.6×10^5 cfu/g) obtained by pot method.
Keyword: Compost, organic farming, microorganisms, composting methods

INTRODUCTION

Organic fertilizers, which are stable, eco-friendly and slowly mineralized materials derived from plant and animal wastes, are fast replacing conventional fertilizers in agricultural production of crops. Organic fertilizers are obtained through composting. Composting has been defined as intense microbial activity leading to decomposition of most biodegradable materials, it is usually done to transform and stabilize the organic materials that are capable of rotting in raw waste into a stable usable product, to produce uniform organic fertilizer suitable for soil amendment and to remove offensive odours, to kill weed seeds and pathogenic organisms (Adani *et al*.,1997,Manral *et al.*, 2003, Ghosh *et al.*, 2004, Akanbi 2007).). This biological process involves the complete or partial degradation of a variety of chemical compounds by a consortium of microorganisms in which the composition and population of these microorganisms' changes as the composting progresses (Whitney and Lynch 1996, Boulter *et al*., 2002). A large variety of mesophilic, thermo tolerant and thermophilic aerobic microorganisms, classed as bacteria, actinomycetes, yeasts, and fungi are involved in the composting process each playing unique roles due to their different characteristics and functions (Beffa *et al*. 1996b, Hassen *et al*., 2002). During composting, microorganisms help in breaking down organic matter to produce carbon dioxide, water, heat and humus. In Nigeria, cassava peels and poultry manure are major sources of organic fertilizer. There are different composting methods that are being practiced all over the globe. Irrespective of

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these, there is paucity of information on the correlation of different composting methods and microbial population. The objective of the study was to determine the relationship between two compost types and microbial community and population during composting process.

MATERIALS AND METHODS

The study was carried out at the floriculture garden of National Horticultural Research Institute, Ibadan, Nigeria. Two methods of composting, pot and pit, were used for this experiment. The composting material consisted of cassava peel and poultry manure at ratio 2:1 on dry weight basis. The pot was a 300 litres plastic container perforated for aeration while the pit was dug and covered with tarpaulin. Microbial analysis of compost was determined at intervals; 4, 12 and 24 weeks of composting and this corresponds to the mesophilic, thermophilic and curing or maturity stages. One gram air-dried compost was placed in 25 ml test tube containing 10 ml of sterile distilled water. The mixture was shaken vigorously to dislodge aggregates, after which serial dilutions of 10^{-3} and 10^{-5} were prepared by sequentially transferring 1 ml sample into another test tube containing 9 ml sterile distilled water. Sub sample 100 µl at selected dilutions were pipetted into four plates containing nutrient agar or potato dextrose agar. Plates were incubated at 28±2°C for 24 hrs (for bacteria) and 48 hrs (for fungi). Compost microbial colonies were counted and recorded as colony forming unit per gram of sample (cfu/g).

RESULTS AND DISCUSSION

Composting usually involve the release of heat as a result of biological and metabolic processes. Figure 1 showed that the drum and pit method of composting was significantly ($P<0.05$) different during the first six weeks compared to ambient composting method. The highest temperature (63°C) was recorded by pit method at day 21 (week 3), while the lowest (23°C) was recorded by ambient method at day 70 (week 10) while was not significantly different from the other methods of composting The two compost (pit and pot) showed similar trend in terms of cfu/g at the initial stage (mesophilic stage) but there was no significant ($P<0.05$) difference between fungi and bacteria communities (Table 1). At thermophilic stage bacterial cfu/g was significantly $p<0.05$ higher (7.4×10^5 cfu/g) compared with fungi population (4.8×10^5 cfu/g). Similar trend was observed at maturity stage where bacteria population was significantly $p<0.05$ higher. Results from table 2 showed that there was no significant difference in microbial population between pit and pot compost except at thermophilic stage where a significantly $p<0.05$ higher microbial population (9.6×10^5 cfu/g) was recorded in pot compost. Microbial diversity is a prerequisite for a satisfactory composting process (Hassen *et al*., 2002). Plate counts are useful techniques for isolating and enumerating fungi and bacteria in compost using varieties of media (Wollum, 1982, Devi *et al*., 2012). Higher bacteria population recorded in this study at thermophilic and maturity stages could be due to the fact that bacteria provide the most rapid and efficient composting excreting plant nutrients such as nitrogen, phosphorus and magnesium (Abu-Bakar, 2015). Studies have also showed that bacteria make up 80-90% microbes in compost and they are responsible for most of decomposition and heat generation in compost (Boulter *et al.*, 2002). Existence of fungi at meshophilic and thermophilic stages of composting have been reported (Kowalik, 2015). Summarily, higher microbial population especially bacteria in the compost is an indication that the material is well composted since population and diversity of microorganisms such as bacteria and

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fungi are important for a satisfactory composting process.

CONCLUSION

The two methods can be employed in compost preparation in the ecological area, both resulted in production of higher microbial population, especially bacteria which is an indication that the material is well composted and can support plant growth and increased soil productivity.

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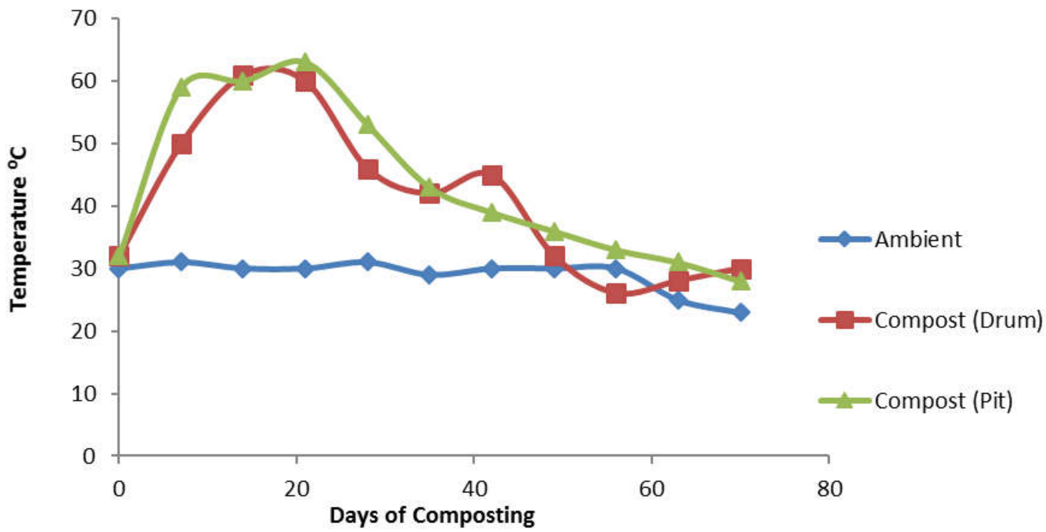

Figure 1: Effects of composting methods on temperature changes during composting

Table 1: Compost microbial population at different composting stage

Microbe	Cfu/g at time interval (weeks)		
	4	12	24
Bacteria	2.6 x 10^6a	7.4 x 10^5 a	1.4 x 10^6a
Fungi	2.0 x 10^6 b	4.8 x 10^5b	7.1 x 10^5b

Table 2: Effect of composting method microbial population at different composting stage

Composting method	Cfu/g at time interval (weeks)		
	4	12	24
Pit	2.3x10^6a	2.6x10^5b	1.1x10^6a
Pot	2.4x10^6a	9.6x 10^5a	9.6x 10^5a

Response of Onion (*Allium cepa*l.) Varieties to Poultry Manure Rate on Growth and Yield at Samaru

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Abstract

Poultry manure is an efficient organic fertilizer and is also an important source of plant nutrients. The study was conducted in 2017 dry season at the Institute for Agricultural Research (IAR) Farm, Samaru in the northern guinea savanna of Nigeria to investigate the response of onion varieties to poultry manure rate on growth and yield under irrigated conditions. Treatments consisted of four (4) levels of poultry manure (0, 2, 4, 6 t ha^{-1} and Recommended NPK fertilizer rate of 300 kg ha^{-1}) and three varieties of onion (Red creole, GalmiSpv andWuyan- Bijimi). All the treatments were factorial combined and laid out in a randomized complete block design (RCBD) which was replicated 4 times.The result revealed that the use of 6 t ha^{-1} poultry manure significantly influenced number of leaves, crop growth rate, onion bulb weight and yield. Therefore, the use of poultry manurewith Wuyan-bijimican be adopted by farmers in this region to enhance the productivity of onion.

Keywords: Poultry Manure Rate, Onion, Varieties Growth, Yield

INTRODUCTION

Onion is an important worldwide vegetable crop (Best, 2000). It belongs to the genus *Allium* of the family *Liliaceae.* It is by far the most important of the bulb crops cultivated commercially in most parts of the world. The crop is grown for consumption both in the green state as well as in mature bulbs. Onions are also vegetables and herbs which also include chives (*Allium schoenoprasum*), garlic (*Allium sativum*), scallions (*Allium fistulosum*) and leeks (*Allium ampeloprasum*). Onion is an important and indispensable item in every kitchen, as a condiment and onion is used in soups, sauces and for seasoning of foods. Onions have a wide range of climatic and soil adaptation and they are cultivated both under irrigation and rain fed conditions (Getachew and Asfaw, 2000; Rabinowitch and Currah, 2002). Despite the ranking of onions as second most important vegetable in Nigeria, the present production levels do not meet the demand of the teeming populace (Gambo*et al*., 2008).

Lack of improved varieties and production practices have been the major bottlenecks of onion production and productivity in Nigeria. Highly adaptable and well performing varieties with improved cultural practice could be a possible way of boosting both quality and marketability of the crop.

The use of inorganic fertilizers alone has not been helpful under intensive agriculture because; it aggravates soil degradation (Sharma and Behara, 2009). The inorganic fertilization is associated with soil which is brought about by loss of organic matter which consequently results in soil acidity, nutrient inbalance and low crop yields (Ayoola and Makinde, 2007).

The benefit of organic manure in crop production is well known and the popular domestic sources are farm yard manure and animal dropping (Isah *et al*., 2014).Organic manure also supplies the necessary minor nutrients that are lacking in inorganic fertilizers. Apart from increasing soil fertility, organic manure also serves as soil amendments by adding organic matter into the soil, this greatly

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improves the soil physical structure thereby enhancing and improving the water holding capacity of the soil, soil aeration, soil structure and texture, nutrient retention, soil porosity and infiltration rate. This research investigated the response of onion varieties to poultry manure rate under irrigated conditions.

MATERIALS AND METHODS

The field study was carried out in 2017 at the Institute for Agricultural Research (IAR) farm ($11^0$11'N, 07^0 38'E) 686m above sea level in the northern guinea savanna of Nigeria. The treatment consisted of four (4) levels of poultry manure (0, 2, 4, and 6 t ha^{-1}), three varieties of onion (Red creole, GalmiSpv, Wuyan-Bijimi). All the treatments were factorial combined and laid out in a randomized complete block design (RCBD) which was replicated 4 times. The poultry manure (Layers) rates (0, 2, 4, and 6 tons per hectare) was incorporated into the ridges after land preparation and allowed to decompose for two weeks before preparing to sunken beds. The treated seeds were sown in the nursery bed 1m x10 width and length using drilling method 10 cm apart for four weeks before transplanting. Prior to the experiment, composite soil samples were collected from the field using a soil auger with diameter of 15 cm. All the data collected were subjected to analysis of variance (ANOVA) using general linear procedure with Statistical Analytic Software (SAS, 2009) and treatment means were compared using Duncan Multiple Range Test (DRMT).

RESULTS AND DISCUSSION

The soil physical and chemical properties are given in (Table 1). The study area is characterized as loam with low N and K contents and high in available P. The low N contents might be attributed to low organic carbon.

Number of leaves was significantly affected by treatment (Table2). Application of poultry manure at 2 t ha^{-1} significantly ($p \leq 0.05$) produces higher number of leaves which was similar with the check NPK fertilizerat 5 WAT. However, application of poultry manure at 4 and 6 t ha^{-1} were significantly similar with the controlat 7 WAT. At 9 WAT, number of leaves significantly ($p \leq 0.05$) increased correspond with the application of poultry manure up to 6 t ha^{-1}.Wuyan-bijimi statistically produce more number of leaves than Galmi and Red creole that are statistically similar.This might be attributed to improved soil with adequate nutrients and subsequent release to fulfil the requirements of the crop. This was in line with the reports of (Faladun*et al*., 2018) who reported that the application of 10 t ha^{-1} poultry manure has a superior effect on proximate composition and most of growth parameters and yield components.

Response of onion varieties and poultry manure rate significantly influenced crop growth rate of onion at 7-9 WAT (Table3).Application of poultry manure on crop growth rate showed significant difference only at 7-9 WAT where application of poultry manure at 6 t ha^{-1} had higher crop growth rate than the other treatments however, applied 4 t ha^{-1} of poultry manure had similar crop growth rate with the other treatments. However NPK fertilizer significantly produced more crop growth rate when compared to poultry manure treatment. At 5-7 WAT, Wuyan- bijimi significantly ($p \leq 0.05$) produced higher crop growth rate that was similar to Galmi, however Galmi and Red creole had similar crop growth rate. At 7-9 WAT, Wuyan-bijimi significantly produced more crop growth rate than Galmi and Red creole that had similar crop growth rate. This is attributed to the sufficient amount of nutrients from the poultry manure in the soil proportional to

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the demand by the plants(Adekiya and Agbede, 2016).

There was significant interaction between poultry manure and varieties on crop growth rate at 7-9 WAT at Samaru (Table 4). Variety Wuyan-bijimi and application of NPK recommended rate significantly produced higher crop growth rate when compared to other treatments interaction. Generally, variety Red creole produce lower crop growth rate through the application of poultry manure.

Table 5 indicated that application of poultry manure at 6 t ha^{-1} significantly ($p \leq 0.05$) increased bulb weight per plant which is statistically similar to 4 t ha^{-1}. However applied poultry manure at 2 and 4 t ha^{-1} had similar bulb weight per plant than control treatment. The check, NPK fertilizer application significantly produced heavier bulb weight per plant when compared to poultry manure application and control.Wuyan-bijimi significantly had more bulb weight per plant than Galmi and Red creole however, Galmi and Red creole were statistically similar. Magdi*et al*. (2009) reported the yield of onion was significantly influenced by fertilizer types. The highest yield of onion bulbs was obtained by the application of 5 t ha^{-1} of chicken manure which increased onion dry matter, weight of individual bulb and bulb diameter.

Application of poultry manure did not significantly increased bulb yield(kg ha^{-1}) but NPK fertilizer application significantly increased bulb yield(kg ha^{-1}). The varieties differs significantly on bulb yield (kg ha^{-1}) at Samaru (Table 5) where Wuyan-bijimi significantly produced more bulb yield (kg ha^{-1}) than Galmi and Red creole lower similar bulb yield kg ha^{-1}.Blay*et al*. (2002) also reported that when poultry litter is applied at the recommended rate, it promotes plant growth and bulb yield.

Poultry manure is known to play an important role in maintaining soil health. The application of poultry manure have led to increasing soil fertility, organic manure also serves as soil amendments by adding organic matter into the soil, this greatly improves the soil physical structure thereby enhancing and improving the water holding capacity of the soil, soil aeration, soil structure and texture, nutrient retention, soil porosity and infiltration rate. Sonetra (2002) suggested that subsistent farmers should apply organic manure directly to the soil as a natural means of recycling nutrients in order to improve soil fertility and crop yield.

CONCLUSION

From the result, it can be concluded that adequate addition of poultry manure at 6 t ha^{-1} with variety Wuyan-bijimi gave the best growth, yield of onion and improved soil conditions in the study area. Therefore, the combination of poultry manure with the variety Wuyan-bijimi should be practiced and encouraged.

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Table 1: Physical and chemical properties of soil at Samaru in 2017

Physical properties (g kg^{-1})	**Samaru**
Sand	430
Silt	460
Clay	110
Textural class	Loam
Chemical properties	
Nitrogen (g kg^{-1})	0.45
Phosphorus (mg kg^{-1})	5.26
Potassium (cmol kg^{-1})	0.11
Organic carbon (g kg^{-1})	0.67

Source: Analyzed Soil Sample at Department of Agronomy, ABU, Zaria

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Table 2: Response of irrigated onion varieties to poultry manure rate on number of leaves per plant at Samaru in 2017 dry season

Treatment	5WAT	7WAT	9WAT
Poultry Manure (t ha^{-1}) P			
0	3.14b	4.58	4.92e
2	3.78a	5.03	5.72d
4	3.31ab	4.72	6.50c
6	3.44ab	4.86	7.08b
NPK (120:45:45)	3.86a	5.11	7.67a
SE±	0.195	0.254	0.072
Variety (V)			
Red Creole	3.30b	4.57b	6.09c
Galmi	3.37b	4.63b	6.38b
Wuya-bijimi (Local)	3.85a	5.38a	6.65a
SE±	0.151	0.197	0.056
Interaction			
P x V	NS	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT.NS= Not Significant. WAT=Weeks after sowing.

Table 3: Response of irrigated onion varieties to poultry manure rate on crop growth rate at Samaru in 2017 dry season

Treatment	5-7WAT	7-9WAT
Poultry Manure (t ha^{-1}) P		
0	0.38	0.09c
2	0.40	0.19c
4	0.40	0.39c
6	0.42	0.83b
NPK (120:45:45)	0.49	2.35a
SE±	0.075	0.120
Variety (V)		
Red Creole	0.30b	0.53b
Galmi	0.40ab	1.71b
Wuya-bijimi (Local)	0.56a	1.08a
SE±	0.058	0.093
Interaction		
P x V	NS	**

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT.NS= Not Significant.* *=significant at 1% level of probability. WAT=Weeks after sowing.

Table 4: Interaction between Poultry manure rate and variety on crop growth rate at 7- 9 WAT at Samaru and 7-9 WAT at Kadawa

	Poultry manure rate (t ha^{-1})				
Variety	0	2	4	6	NPK kg ha^{-1}
Red Creole	0.05f	0.16f	0.31ef	0.55def	1.58bc
Galmi	0.10f	0.19ef	0.41ef	0.86de	1.96b
Wuyan-bijimi	0.13f	0.23ef	0.44ef	1.09cd	3.51a
SE±			0.207		

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT. WAT=Weeks after sowing.

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Table 5: Response of irrigated onion varieties to poultry manure rate on bulb weight (g) per plant and bulb yield per hectare kg ha^{-1}at Samaru in 2017 dry season

Treatment	Bulb weight (g) per plant	Bulb yield per hectare kg ha^{-1}
Poultry Manure (t ha^{-1}) P		
0	125.3bc	4509.8e
2	134.8bc	7450.9d
4	147.9c	10539.2c
6	172.3b	15294.0b
NPK (120:45:45)	214.1a	22597.9a
SE±	14.60	851.09
Variety (V)		
Red Creole	138.3b	10323.4b
Galmi	114.8b	11794.0b
Wuya-bijimi (Local)	229.7a	14117.8a
SE±	11.30	659.25
Interaction		
P x V	NS	NS

Means followed by the same letter(s) in the same column are not different statistically at 5% level using DRMT.NS= Not Significant.

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Fruit–Setting in Okra (*Abelmoschus esculentus* L. Moench) Varieties Affected by Application of Poultry Manure at Samaru

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Abstract
Okra is an important vegetable fruit in Nigeria as it is a rich source of vitamins, carbohydrate, proteins and minerals.However, in the crisis and scarcity of industrial fertilizer, poultry manure which is rich in nutrient such as nitrogen, phosphorous and potassium is readily available and cheap could be an alternative source of nutrition for improved growth and yield of okra. In the study, the effect of poultry manure on fruit-setting in okra at different levels (200, 100, 50, and 0kg/ha) using four varieties of okra (Clemson spineless, Ex-samaru5, Jokoso and NHAe47-4) was determined. The poultry manure used was analyzed before application. The experiment was laid out in a split plot design, replicated three times. Data were collected on number of fruits, fruit fresh weight(g)/plant, fruit yield/ha and fruit dry weight(g). Application of poultry manure at (200kg/ha) had highly significant effect (P≤0.01) on all the measured traits. However poultry manure at rate of 200kg/ha to Jokoso okra variety produced the highest fruit yield of 8.61tons/ha and can therefore be appropriate for optimum okra production.

***Key**: Poultry manure, Okra Variety*

INTRODUCTION

Okra(*Abelmoschus esculentus* L. Moench.) is a popular home garden vegetable which belongs to the family *Malvaceae*(Iremiren, 1988). Several varieties abound and vary by height, fruit size and color, earliness, and response to photoperiod (Udoh *et al*., 2005).It is one of the most prominent and lucrative vegetables used in fresh and canned forms (PROTA, 2010).The edible portions of the pod are good sources of protein as well as an ascorbic acid content of 20g\100g and high level of calcium, fiber ash; and mature seeds contain about 21% of edible oil (Uguru, 2011). This crop can perform very well in most tropical and provides human supplementary vitamins such as A, B-Complex, C, iron and calcium (Akanbi *et al*., 2010; Jaibir, *et al*., 2004). Okra is an adaptable plant that grows on any type of soil between latitude 30°Nand 30°S of the equator (Kenneth, 1985). The plant thrives well in full sunlight but also tolerate moderate shade. According to (Yamaguchi, 1983), okra grows best when minimum and maximum temperature are at 18°Cand 35°C respectively. But (Schipper, 2000) stated that the crop does not grow well when temperature drops below 20°C respectively. *Abelmoschus esculentus* (L.) which likes plenty sunshine and does not tolerate too much shade. The optimum soil pH of 6-6.8 with an annual rainfall of 750mm and a well-drained fertile soil with an adequate organic matter and also rich in major mineral elements. Production constraints of okra in Nigeria have been relatively modest. Even in cases where high yielding cultivars have been grown the inherently low fertility status of the soils coupled with mineral application of fertilizers remain the principal limiting factor to okra production especially in the forest region of Nigeria and deficient soil moisture in Savanna region.( ). A continual dependence on chemical fertilizer may be accompanied by a fall in organic matter content, increased soil acidity, degradation of the soil physical properties and increased rate of erosion due to instability of soil aggregates(Olowoake,2014). In recognition of high energy cost, rise in price and scarcity of inorganic fertilizer in developing countries, there is need for alternative source of nutrient for improved okra production especially. As long as

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poultry manure are relatively cheap, readily available and comparable to inorganic fertilizer in terms of crop yield improvement, their uses as a source of plant nutrient for growing vegetable crops assume increasing importance. This study was therefore conducted to determine the response of fruit-setting in okra varieties to different levels of poultry manure.

MATERIALS AND METHODS

The experiment was conducted on the experimental site of Horticultural garden, Institute for Agricultural Research, Samaru Zaria, located on latitude $11^0$11'N and longitude $07^0$38'E, at and altitude of 686 meters above sea level during the 2014/2015 dry season at Samaru. Zaria is located in the Northern Guinea Savannah agro-ecological zone of Nigeria. The average annual rainfall is about 1058mm which is distributed within 160days (April-October). A composite soil sample was taken at 0-15 cm depth with a 15 cm diameter soil auger for textural class. Mineral composition in poultry manure was also analyzed. The land was measured 6 m × 6m and cleared, then sunkend beds 0f 0.18m were made manually with hand hoe laid out in split plot design and replicated three times. Four varieties (Clemson Spineless, Ex-Samaru5, Jokoso and NHAe47-4) obtained from Seed unit of Artemisia Research Programme, IAR Zaria and poultry manure obtained from National Animal Production Research Institute Ahmadu Bello University Zaria.The trial was conducted using Split Plot Design which consisted of sixteen (16) treatment combinations replicated three times. Different rates of poultry manure 200,100,50 and 0kg/ha and four okra varieties Clemson Spineless, Ex-Samaru5, Jokoso and NHAe47-4 constitute the treatment. Three seeds were initially sown per hole with inter and intra row spacing of 30cm by 30cm respectively reseeding was followed up for missing stands 9days after the first planting which was later thinned to one plant per stand at 3 WAS leaving a total of 24plants per plot. Manual weeding with hand hoe was carried out at 3, 5 and 7 weeks after sowing (WAS). Three plants were randomly selected and tagged in each plot and all observations were taken.

Data on yield characters; number of fruits/plant, fruit fresh weight, fruit yield and fruit dry weight were collected at 12 weeks after sowing (WAS). Data collected were subjected to analysis of variance (ANOVA) using SAS. Characters showing significant differences were separated using least significant difference (LSD) at 5% and 1% level of probability.

RESULTS AND DISCUSSION

The results analysis of variance indicated that number of fruits and fruit fresh weight showed highly significant variation among varieties and levels of poultry manure and interaction ($P \leq 0.01$) between okra varieties and the levels of poultry manure applied (Table 2).The performance for number of fruit showed that variety Ex-Samaru 5produced relatively highest number of fruits of 2.70 with application of 200kg/ha across all the varieties and poultry manure applied (Table 3). The increase in fruits number could be attributed to the ability of poultry manure to promote vigorous growth, increase meristematic and physiological activities in the plants due to the supply of plant nutrient and improvement in the soil properties, thereby, resulting in the synthesis of more photo-assimilates, which is used in producing fruits (Dauda *et al.,*2008). The performance for fruit fresh weight showed that variety Jokoso had relatively highest fruit fresh weight of 10.77g/plant with application of 200kg/ha poultry manure compared to Ex-Samaru 5, Clemson Spineless and NHAe47-4 that had fresh fruit weights of 7.60, 7.17 and 5.20 (g) respectively and this is due to the fact that the variety Jokoso fresh pods are longer, bigger, thicker and heavier with large

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seeds hence increase in weight. Dademel *et al.,* (2004) reported that the nitrogen content in organic fertilizer has been known to enhance leaf production, flowering, seed formation and root formation, this will lead to high metabolic activities and consequently higher fresh fruit in okra.

Across the four varieties, the study showed that application of 200kg/ha of poultry manure resulted in a significant increase in number of fruit and fruit fresh weight (Table 3). Also, there was a significant increase in performance depending on the variety in the control plot reason been that the soil contains nutrient that was gotten as a result of the soybean that was cultivated on the field the previous year.

The result analysis of variance indicated that there was no statistical significant interaction ($P \geq 0.05$) among varieties and 4 levels of poultry manure on fruit yield and fruit dry weight(Table 2). However, the performance showed that variety Jokoso gave the highest fruit yield and fruit dry weight of 8.61ton/ha and 15.35g with application of 200kg/ha these could be due to the fact that poultry manure is attributed to easy solublization effect of released plant nutrient leading to improved nutrient status of the soil as related to the findings of Onwu *et al.,*(2014) which reported that yield of okra can be increased due to organic manure application. The rate of pod development is rapid up to nine days after anthesis and slows down thereafter. The number of fruits per plant is a major yield index in okra.The supply of nutrient operates as a means of increasing yield with certainty and at the same time improving the quantity and quality of the crop. The higher the number of fruits the higher is the first yield realized (Fatokun *et al.,* 1981). The variety Jokoso with higher dry matter content is due to the fact that it is relatively more vigorous, an experimentation of the growth pattern revealed that early and faster accumulation of dry matter at 8-12 WAS. The variety Clemson Spineless and Ex- Samaru 5 gave a considerable fruit yield at poultry level 100 and 50kg/ha respectively, variety NHAe 47-4 gave the least.

CONCLUSION

It is hereby concluded that the effect of poultry manure on fruit-setting in okra varieties evaluated in this study varied greatly. This wide variability might be due to their root architecture in absorbing nutrient that should be redistributed for the growth and development of the crop. However,the performance of Jokoso okra variety compare to other varieties to application of poultry manure at rate of 200kg/ha produced the highest fruit yield of 8.61ton/ha which implies that poultry manure at these rate was better on the variety than other rate and could conveniently be used in okra production soil amendment. In order to maximize yield of okra under small or large scale agriculture an early application of well-rotted poultry manure at the rate of 200kg/ha along the row to Jokoso variety will be appropriate for optimum production of okra and therefore recommended to farmers in Samaru.

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Table 1 Physio-Chemical Properties of Soil taken from the Experimental Site and the Poultry Manure Analysis.

Physical Classification (%)	**5cm(Depth)**
Sand	60
Clay	18
Silt	22
Textural class	Sandy loam
Chemical Classification	
pH(Water)	5.7
pH ($Cacl_2$, 0.01M)	5.0
Organic Carbon (%)	0.57
Total Nitrogen (%)	0.007
Available Phosphorus (ppm)	14.88
Exchange bases (CMol/Kg)	
Ca	2.63
Mg	0.53
K (Cmol/Kg)	0.29
Na	0.37
H+Al	0.6
CEC	5.4
Poultry Manure Analysis(%)	
N	1.54
P	0.926
K	0.625
Na	0.168
Ca	0.554
Mg	0.113
Zn Mg/Kg	131.5
Fe Mg/Kg	2498.3
Mn Mg/Kg	107
Pb Mg/Kg	11.5

Table 2 Analysis of Variance of Number of fruits per plant, Fruit fresh weight, Fruit Yield and Fruit dry weight Using 4 levels of Poultry Manure and 4 Varieties of Okra grown at Samaru in 2015

Source of variance	DF	Mean square			
		NFR	FFW(g)/plant	FY(ha)	FDW
Replication	2	0.09	1731.46	7.14	14.68
Variety(V)	3	3.89**	18768.51**	33.98**	361.79**
Poultry manure(PM)	3	0.58**	2795.49**	12.27**	29.378**
V × PM	9	1.07**	811.38**	1.31^{NS}	5.96^{NS}
Error	30	0.10	177.79	1.87	4.13
CV (%)		25.61	21.86	21.57	27.93

** =significant at 1% level, NS=Non Sinificant, DF= Degree of Freedom, NFR=Number of Fruits, FFW=Fruit Fresh Weight(g), FY= Fruit Yield, FDW=Fruit Dry Weight(g) and CV=Coefficient of Variance.

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Table 3 Shows Mean Performance for Number of fruits and Fruit fresh weight at 12 WAS of 4 Varieties of Okra using 4 levels of Poultry Manure Evaluated at Samaru in 2015.

	Number of Fruits					Fruit Fresh Weight (g)				
	V_1	V_2	V_3	V_4	Mean	V_1	V_2	V_3	V_4	Mean
200kg/ha	2.67	2.70	1.03	1.00	5.4	7.17	7.60	10.77	5.20	30.74
100kg/ha	1.23	1.70	-0.00	1.00	3.93	5.30	5.93	8.67	3.80	23.70
50kg/ha	0.00	1.30	1.57	1.67	4.54	6.27	6.20	8.30	5.00	25.77
0kg/ha	1.00	0.34	0.23	0.23	1.8	3.73	3.60	4.60	2.17	14.10
Mean	4.90	6.04	2.83	3.90		22.47	23.33	32.34	16.17	
SE$\pm$	0.18					0.79				

V_1= Clemson Spineless, V_2= Ex-Samaru 5, V_3= Jokoso, V_4= NHAe 47-4

Table 4: Mean Performance for Fruit Yield and Fruit Dry Weight(g) at 12 WAS of 4 Okra Varieties using 4 levels of Poultry Manure Evaluated at Samaru in 2015.

Treatment	Fruit Yield(ha)	Fruit Dry Weight(g)
Variety		
V_1= Clemson Spineless	6.12^{b}	4.41^{bc}
V_2= Ex-Samaru 5	6.08^{b}	5.80^{b}
V_3= Jokoso	8.61^{a}	15.39^{a}
V_4= NHAe47-4	4.54^{c}	3.51^{c}
SE$\pm$	0.39	0.59
Poultry manure		
200kg/ha	7.68^{a}	8.91^{a}
100kg/ha	5.93^{bc}	8.06^{ba}
50kg/ha	6.44^{b}	6.84^{bc}
0kg/ha	5.30^{b}	5.31^{c}
SE$\pm$	0.39	0.59
V $\times$ P	NS	NS

V= Variety, P= Poultry manure, NS= Non Significant

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Effect of Organic Manure on Duration of Ripening of Four Tomato (*Lycopersicon esculentum* Mill.) Varieties Selected under Four Seedling Ages.

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Abstract
An experiment was conducted at the experimental field of National Horticultural Research Institute, Ibadan, Nigeria on effect of organic manure on duration of ripening of four tomato(Lycopersicon lycopersicon Mill.) varieties selected under four seedling ages. The treatments were four tomato varieties (Tropimech, Alahausa, Cobra and RomaVF), two organic manures (Aleshinloye organic manure and Poultry manure) and tomato samples selected under four seedling ages (1st week, 2nd week, 3rd week and 4th week respectively). The tomatoes were harvested at mature green fruits and five samples were sorted to represent each treatment and observed for eight days. The atmospheric temperature, relative humidity and pressure were taken for each day and recorded. Tomat colour changes was carried out using the human eye in the absence of colorimeter. Data were collected on ripening index (1-4 as yellow & 5-8 as red) with maximum and minimum atmospheric mean temperature as 29.8°C and 31.3°C respectively, relative humidity as 60% and 74% respectively and atmospheric pressure as 732mmHg and 759mmHg respectively. Data were analyzed using analysis of variance (ANOVA) and treatment means compared with least significant difference at 5% probability level. The effect of ripening days had high significant effect on tomato varieties for days 4, 6, 7 and 8 which were the highest among the treatments under consideration. However, manure types used did not have significant effect on Days 1, 2, 3 and 5 of the ripening days. Alahausa tomato variety showed the best ripening index among the four tomato varieties with the highest mean value (put value), hence it showed good storage ability under temperature of 29.8 °C and 31.3°C respectively.
Keywords*: Tomato varieties, seedling age, manure types and ripening index*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) belongs to the family of solanacea and the genus *lycopersicon* (Vander *et al.,* 2004). In Nigeria, the problem of the various stakeholders in the tomato industry has mostly been on lack of proper agronomic practices which is commonly found in the south western part of the country. Tomato sector in particular have not met their potential due to production techniques and storage. Environmental conditions, nutrient requirement and management practices also play a large role in how the plant performs. Tropical soils are beset with the problems of acidity, low nutrient contents, nutrient imbalance and erosion. Use of organic fertilizer has been found to solve these problems (Babatola and Olaniyi, 1997; Senjobi *et al*., 2012). The major limitation to the usage of chemical fertilizer is the adverse effect they have on plants which include reduction of plant quality, disease susceptibility, environmental pollution and unsafety food (Adeoluwa and Adeogun 2010).

However, when more precise colour description is needed, instrument such as colorimeters are used in measurement. Where human perception is required and where all conceivable colours can be located within the colour sphere defined by three perpendicular axes, L* (from white to black), a* (green to red) and b* (blue to yellow) (Heilderberg CPS, 1999). Shewfelt (1993) stated that humans and colorimeters measure colour in a different way: humans see colors in terms of lightness, hue and chroma by integrating complex perceptions. Instruments, on the other hand, are able to see pure values of any L*, a* and b* in the absence of the others. A given colour in tomato is fully defined when the achromatic component L* (relative darkness or lightness) is measured in addition to the chromatic descriptors (a* and b* values) (Pérez-Alvarez *et al*., 1999; Heildelberg CPS, 1999). Based on the external colour, the USDA establishes six ripening stages reflecting human ability to differentiate ripeness: *green*, 100% green; *breaker*, a

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noticeable *break* in color with lesser than 10% of other than green color; *turning*, between 10 and 30% of surface, in the aggregate, of red(ish) color; *pink*, between 30 and 60% of red(ish) color; *light red*, between 60 and 90% and ***red***, more than 90% red (The California Tomato Board, 1975). Tomato has short storage shelf life and this has highly affected its storage ability. Most people harvest at different stages of ripening such as when the tomato surface is completely green. The shade of green may vary from light to dark. Breakers, there is a definite break of colour from green to bruised fruit tannish-yellow, pink or red or 10% or less of the tomato surface. Turning, tannish-yellow, pink or red colour shows on over 10% but not more than 30% of the tomato surface. Pink**,** Pink or red colour shows on over 30% but not more than 90% of the tomato surface. Light red, Pinkish-red or red colour shows on over 60% but red colour covers not more than 90% of the tomato surface. The final stage which is the maturity stage and ripening stages, tomato turns red; meaning that more than 90% of the tomato surface in aggregate is fully red. With the full understanding of tomato ripening stages, this would reduce the rapid quality loss at relatively short period of 4 - 7days; hence, the need for an efficient means of storing the fruit to reduce wastage according to Thompson *et al*., 1998 and also improve intake and market acceptability. Thus, this experiment was carried out to find the effect of organic manure on duration of ripening of four tomato (*Lycopersicon lycopersicon* Mill.) varieties selected under four seedling ages

Materials and Methods

The experiment was carried out at the research laboratory of the National Horticultural Research Institute (NIHORT), Ibadan, located in the forest agro-ecological zone of Nigeria (Latitude 7° 22’ N and Longitude 3° 50’ E at an altitude of 234m above sea level). The treatments were four tomato varieties (Tropimech, Alahausa, Cobra and RomaVF), two organic manures (Aleshinloye organic manure and Poultry manure) and tomato samples selected under four seedling ages (1st week, 2nd week, 3rd week and 4th week respectively). The tomatoes were harvested at mature green fruits and were sorted into each treatment. Five samples of tomato were selected to represent each treatment and were observed for eight days. The atmospheric temperature, relative humidity and pressure were taken for each day and recorded. Tomato colour changes or colour development occurs in tomato which is temperature sensitive with better plastid conversion occurring above 12°C and below 30°C (Thai *et al*., 1990). However, this experiment was carried out using the human eye in the absence of colorimeter. The colour changes were given ranges such as 1-3 =Light Yellow, 4-6 =light red or pink, 7= red and 8 =Full red. Data were taken for eight days using these colour indicators. The data taken were subjected to analysis of variance with significant mean separated using least significant difference (LSD) at 5% probability level using Genstat 7.2.

RESULT AND DISCUSSION

Table 1 show the interaction effects between tomato varieties (V) and manure applied (F) on ripening days of tomato. It shows that V2F1 (Alahusa variety + Aleshinloye manure) had the highest values on days 1, 2, 3, 4, 6, 7 and 8 with values of 3.088, 4.000, 4.667, 5.833, 7.333, 8.417 and 9.167, respectively though at par with V4F1 on days 3 and 7, and with V2F2 on day 8 but second to V4F1 on day 5 with a value of 6.667. V3F2 (Cobra + Poultry manure) had the least values (1.917, 2.250, 5.833, 7.833 and 8.917) on days 1, 2, 5, 7 and 8, respectively though at par with V3F1 on days 5, 7 and 8 which also had least values (3.583 and 6.667) on days 3 and 6. Days 1, 2, 4, and 7 showed no significant

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difference on this interaction, days 5 and 6 was significantly different while days 3 and 8 was highly significantly different.

Table 2 shows the effect of tomato varieties, seedling age and manure applied on the ripening of tomato. It was observed that V2 (Alahusa variety) had the highest colour change from day 1 to day 8 with values of 2.625, 3.625, 4.458, 5.583, 6.500, 7.250, 8.208 and 9.042, respectively while V3 (Cobra variety) had the least while value of colour change for all the ripening days. Results also showed that there was no significant difference in the means of varieties on day 1, days 2, 3 and 5 showed significant difference between the varieties selected and ripening days while days 4, 6, 7 and 8 showed high significant difference between the varieties and ripening days. For the types of manure applied, it was observed that F1 had the highest value (2.438, 3.396, 4.312, 5.417, 6.375, 7.146 and 8.104) for day 1 to day 7, respectively while F2 had the least values but was at par with F1 on day 8 with a value of 9.00. However, days 1, 2, 3, and 5 showed no significant difference while ripening on days 4, 6, 7 and 8 showed significant difference in the means.

For the effect of seedling age on ripening days, results showed that S1 (seedling age at 1st week) had the highest values (2.333 and 3.250) on days 1 and 2, respectively while S4 (seedling age at 4th week) and S3 (seedling age at 3rd week) had the least values of 1.167 and 3.042 on day 1 and 2, respectively. S2 had the highest values (4.294, 5.375 and 6.292) on days 3, 4 and 5, respectively while S1 had least values (6.167 and 6.875) on days 6 and 7 with S3 and S4 at par on day 7. On 8th day of storage, S3 (seedling age at 3rd week) showed the highest mean of 9.083 while S2 (seedling age at 2nd week) was the least. However, on day 1 and 5 the seedling age effects had no significant difference on the ripening days while days 2, 3, 4, 7, and 8 showed significant difference and day 6 was highly significant,

In conclusion, Alahusa variety (V2) among other varieties under investigation had the best ripening index on days 1 - 8 as seen in figure 1 and this was in consonant with a previous trial experiment carried out at National Horticultural Research Institute, Ibadan on growth and yield of tomato varieties where Alahusa variety has the highest dry matter, fruit weight, number of fruit which are indicators for best growth parameters and yield outputs (Dixon, *et. al*., 2017). Also, Wilson *et al*. (1995) in their report on post-harvest handling and cooling of fresh fruits, vegetables and flowers for small farms, asserted that deterioration of fresh commodities can result from physiological breakdown due to natural ripening processes, water loss, temperature injury, physical damage, or invasion by microorganisms and that all of these factors can interact and all are influenced by temperature. The experiment was carried out under maximum and minimum atmospheric temperature between 29.8°C and 31.3°C respectively, relative humidity 60% and 74% respectively and the atmospheric pressure732mmHg and 759mmHg respectively.

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Table 1: Interactive effect of tomato varieties and manure types on ripening days.

	Day1	**Day2**	**Day3**	**Day4**	**Day5**	**Day6**	**Day7**	**Day8**
V1F1	2.250	3.333	4.333	5.333	6.250	7.250	8.083	8.917
V2F1	3.088	4.000	4.667	5.833	6.667	7.333	8.417	9.167
V3F1	2.417	2.917	3.583	4.917	5.833	6.667	7.833	8.917
V4F1	2.000	3.333	4.667	5.58 3	6.750	7.333	8.083	9.000
V1F2	2.000	2.750	3.750	4.667	6.000	6.917	8.083	9.167
V2F2	2.167	3.250	4.250	5.333	6.333	7.167	8.000	8.917
V3F2	1.917	2.250	3.833	5.000	5.833	6.750	7.833	8.917
V4F2	2.000	3.000	4.083	5.083	6.083	7.083	8.000	9.000
Significant	Ns	Ns	**	Ns	*	*	Ns	**
L.S.D$_{0.05}$	1.171	1.750	0.033	1.166	0.041	0.042	0.584	0.025

V1=Tropimech,V2=Alahausa,V3=Cobra,V4=RomaVF F1=Aleshiloye manure,F2= Poultry manure Ns=Not significant,

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Table 2: Main effect of organic manure on duration of ripening on tomato varieties selected under four seedling age.

	Day1	Day2	Day3	Day4	Day5	Day6	Day7	Day8
V1	2.125	3.042	4.042	5.000	6.125	7.083	8.083	9.042
V2	2.625	3.625	4.458	5.583	6.500	7.250	8.208	9.042
V3	1.958	2.792	3.708	4.958	5.833	6.708	7.833	8.917
V4	2.208	3.167	4.375	5.333	6.417	7.208	8.042	9.000
Significant	Ns	*	*	**	*	**	**	**
L.S.D$_{0.05}$	0.247	0.046	0.050	0.026	0.048	0.033	0.021	0.039
F1	2.438	3.396	4.312	5.417	6.375	7.146	8.104	9.000
F2	2.021	2.917	3.979	5.021	6.062	6.979	7.979	9.000
Significant	Ns	Ns	Ns	*	Ns	*	*	*
L.S.D$_{0.05}$	1.216	0.918	0.621	0.049	0.317	0.032	0.049	0.028
S1	2.333	3.250	4.083	5.167	6.167	6.875	7.917	8.958
S2	2.208	3.208	4.292	5.375	6.292	7.000	8.000	8.917
S3	2.208	3.042	4.125	5.250	6.208	7.167	8.125	9.083
S4	1.167	3.125	4.083	5.083	6.208	7.208	8.125	9.042
Significant	Ns	*	*	*	Ns	**	*	*
L.S.D$_{0.05}$	0.198	0.040	0.035	0.032	1.721	0.021	0.050	0.041

V1=Tropimech,V2=Alahausa,V3=Cobra,V4=RomaVF F1=Aleshiloye manure,F2= Poultry manure. S1=Seedling age at 1week, S2= Seedling age at 2weeks, S3= Seedling age at 3weeks, S4= Seedling age at 4weeks. Ns=Not significant.

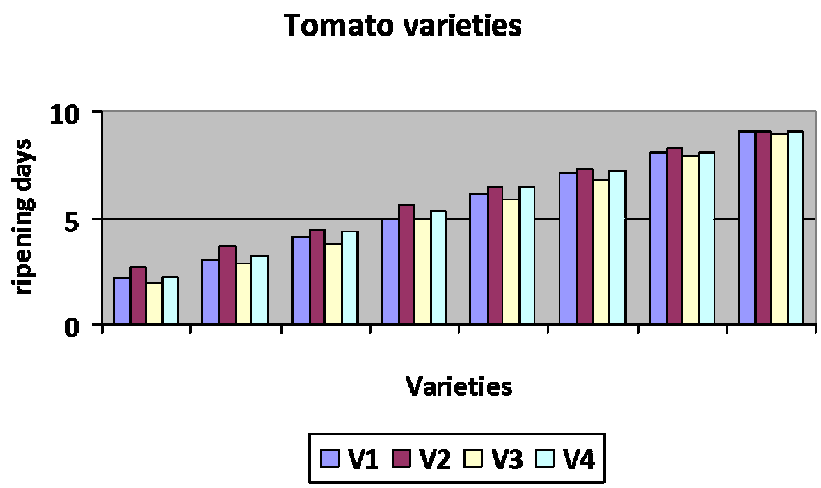

Figure 1: Bar chat showing the progression of tomato varieties with ripening days.

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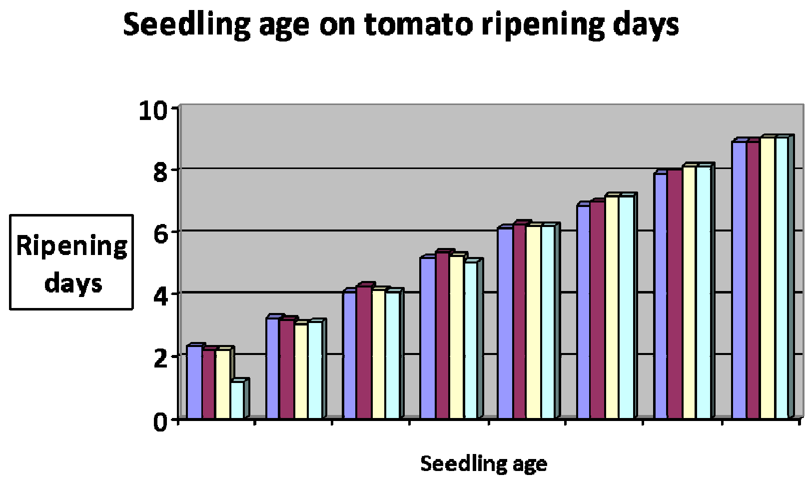

Figure 2: Bar chat showing the trend of tomato seedling age on tomato ripening days.

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Growth Analysis and Leaf Yield in Moringa (*Moringa oleifera* Lam.) as Affected by Nitrogen Rates and Intra Row Spacing in the Northern Guinea Savannah of Nigeria

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Abstract
Two field trials were conducted during the wet season of 2015 at the research farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Samaru ($11^0$11'N; 7^0 38'E and 686m above sea level), and research farm of KADP Maigana, Kaduna state ($11^0$4'N;$07^0$45'E and 595m above sea level) both located in the Northern Guinea savannah Ecological Zone of Nigeria.
The treatments consisted of four levels of nitrogen (0, 50,100 and 150kg N/ha) and three plant spacings (20cm, 30cm and 40cm). The experiment was laid out in a randomized complete block design (RCBD) with three replications. All the rates of nitrogen were comparable and higher than the control at 6 and 12WAS in Samaruand 6 and 8WAS in Maigana. Planting at 20cm intra-row spacing produced significantly higher LAI at 6 and 8 WAS in both locations. Nitrogen application and varying intra row spacing also positively affected CGR and fresh leaf yield at both sites. Based on the findings, intra-row spacing of 30cm and Urea fertilizer rate of 150kg N ha is recommended for the cultivation of DRUMSTICKMoringaoleiferaLam for biomass production in the Northern Guinea Savannah of Nigeria.
Keywords: Moringa, Nitrogen, Spacing

INTRODUCTION

Drumstick (*Moringa oleifera* Lam) is a miracle tree. It is valued worldwide for its ability to treat numerous diseases. It has the ability to retain high concentration of electrolytes, minerals and improves internal hydration (Fuglie, 2003). The cultivation of *M. oleifera*on a large scale is yet to gain popularity in the country. This is as a result of the inadequate information on the management and best agronomic practices for the crop.

Elsewhere, Dash and Gupta (2009) reported maximum number of leaflets and plant height with increased nitrogen. Dahiru (2012) obtained highest *moringa* leaf yield with application of poultry manure and NPK fertilizer. A similar increase in leaf yield with N application was also reported by Adamu (2013).Foidl*et al.* (2001); Gosh (2012) reported maximum biomass value at close planting densities, they found that at higher planting densities, more biomass and yield can be obtained. In view of the importance of *M.oleifera,*its nutritional value to both human and animals in the society, the present study was undertaken in order to generate new information on the nitrogen requirements of the crop and also the best spacing for field production.

MATERIALS AND METHODS

Two field trials were conducted during the wet season of 2015 at the research farm of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Samaru ($11^0$11'N; 7^0 38'E and 686m above sea level), and research farm of KADP Maigana, Kaduna state ($11^0$4'N;$07^0$45'E and 595mabove sea level) both located in the Northern Guinea savannah Ecological Zone of Nigeria,

The treatments consisted of four levels of nitrogen (0, 50,100 and 150kg N/ha) and three plant spacings (20cm, 30cm and 40cm). The experiment was laid out in a randomized complete block design (RCBD) with three replications.

The two fields were ploughed and harrowed to a fine tilth and ridged, marked out into plots.A gross plot size of 10.8m^2 and net plot of 3.6m^2 were used. Seeds were sown manually on the 7thJune, 2015 at Samaru and 26th June, 2015 at Maigana.

Inter- row spacing of 75cm was used while the intra row spacing was as per the treatments(20, 30 and 40cm). Nitrogen in the form of urea was applied in two equal split doses as per the treatment(0, 50,100 and 150kg N/ha). The first dose was applied 2 weeks after sowing (WAS) while, the second dose was applied at 6WAS by side dressing.

Appropriate agronomic and crop protection practices were done to ensure optimal crop performance. Growth analysis (Leaf area index, LAI and Crop growth rate,CGR) was done in accordance with Watson (1952). Data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). The treatment means were compared using Duncan Multiple Range Test (Duncan 1955).

RESULTS

Leaf area index as influenced by nitrogen application and intra-row spacing at both locations during the 2015 wet season is shown on Table 1.The effect of N application on LAI at all sampling periods in both locations was not consistent. All the rates of nitrogen were comparable and higher than the control at 6 and 12WAS in Samaruand 6 and 8WAS in Maigana. Planting at 20cm intra-row spacing produced significantly higher LAI at 6 and 8 WAS in both locations.

Crop growth rate (CGR) of *moringa* as influenced by nitrogen rates and intra-row spacing during the 2015 wet season in both locations is presented in Table 2. At 10WAS, 50kg N/ha resulted in the highest CGR, while at 12 WAS 150 kg N/ha significantly resulted in the highest CGR in both sites. The widest spacing of 40cm significantly increased CGR at 10WAS in both locations, while 30cm was the best at 12WAS in both sites. Table 3 presents total fresh leaf yield as affected by nitrogen rate and intra-row spacing during the 2015 wet season atSamaru and Maigana and Combined.In both locations and the combined data, application of 150kg N ha^{-1} produced significantly higher total leaf yield per ha compared to other applied rates of N.Intra-row spacing of 30cm significantly out yielded others in both locations and combined. Interaction between the two factors was not significant on the parameters reported.

DISCUSSION

The favourable and positive increase in these parameters with increase in nitrogen application could be attributed to increase in meristematic and physiological activities in the plants well supplied with nitrogen. This consequently resulted in the synthesis of more assimilates. Aliyu, (2000, 2002) also reported the beneficial effects of nitrogen on crop plants at various stages of development. For instance, the significant response of growth parameters such as leaf area index (LAI), crop growth rate and fresh leaf yield at both locations could be attributed to the fact that among various nutrients, nitrogen is the most important for *moringa* growth, development and production.

In addition, the significant response to nitrogen fertilization during vegetative growth may be due to the role of nitrogen on the synthesis of chlorophyll, enzymes and protein which increases the vegetative growth. Leaf area index increased with increase in Nitrogen rate application which subsequently influenced more solar radiation interception by the plants and this was utilised for photosynthesis as reported by Ayub*et al.,*(2002). Nitrogen is an important component of chlorophyll which enhances photosynthesis and promote vegetative growth thereby increasing production of assimilates which translate into yield.

There was an increase in leaf area index (LAI) at the lowest intra-row spacing which was also reported byGoss (2012) who observed increased biomass production and leaf area index when planted at higher density.The robust and

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luxury growth and development of *Moringa* observed was significantly influenced by intra-row spacing as reported byBala, (2012) who reported that the closest spacing of 10cmx10cm resulted in highest yield of fresh leaf of *Moringa*.
However, the decrease in crop growth rate with close spacing could be due to intense competition for growth factors at closer spacing compared with wider spacing. Aliyu *et al.* (2014);Daure*et al.*(2014) similarly reported decrease in crop productivity per plant with closely planted crops in their studies. They explained that the increase in population density at the closer spacing exerts an adverse effect on the development of buds from which the leaves and branches develop owing to the vigorous competition among plants at such close spacing.
Conversely total yieldper hectare increased with close spacing. This could be due to the fact that the larger number of plants per area at close spacing more than compensated for low productivity per plant.Goss (2012) also reported similar findings, stating that biomass of *Moringa* plants increased when plant density was increased from 49,384 plants/ha to 197,528 plants/ha. He argued that the plants at higher planting densities efficiently compete with each other for the more limiting resources, which resulted in root elongation and expansion.

CONCLUSION

In conclusion, the overall result of the studies demonstrated that *M. oleifera* grown at 30cm intra-row spacing and 150kg N ha of nitrogen recorded the highest total leaf yield. Based on the above findings, a suggestion of 30cm intra-row spacing and Urea fertilizer rate of 150kg N ha will be the best for the cultivation of DRUMSTICK *(M.oleifera* Lam) for biomass production in the Northern Guinea Savannah of Nigeria.

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Table 1.Effect of nitrogen rates and intra-row spacing on leaf area index of Moringa in 2015 wet season at Samaru and Maigana

	Leaf area index (LAI)							
	Samaru				Maigana			
Treatments	6WAS	8WAS	10WAS	12WAS	6WAS	8WAS	10WAS	12WAS
Nitrogen N (kg/ha)								
0.0	0.19b	0.24c	1.00b	1.38b	0.16b	0.22b	0.94	1.36
50	0.22a	0.34a	1.09b	1.91a	0.25a	0.32a	1.18	1.47
100	0.23a	0.29bc	1.41a	1.64a	0.27a	0.28a	1.14	1.48
150	0.26a	0.29bc	1.17b	1.53a	0.19ab	0.27a	1.16	1.58
SE±	0.024	0.030	0.146	0.177	0.033	0.027	0.137	0.188
Intra-row spacing (cm)								
20	0.25a	0.32a	1.10b	1.43b	0.25a	0.35a	1.17	1.43
30	0.20b	0.26b	1.38a	1.98a	0.21b	0.28b	1.26	1.45
40	0.22b	0.25b	1.03b	1.45b	0.19b	0.27b	0.87	1.56
SE±	0.021	0.026	0.126	0.153	0.028	0.024	0.118	0.163
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT
NS = Not significant

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Table 2: Effect of nitrogen rates and intra-row spacing on crop growth rate of Moringa in 2015 wet season at Samaru and Maigana

	Crop growth rate(g/wk) check unit					
	Samaru			Maigana		
Treatments	8WAS	10WAS	12WAS	8WAS	10WAS	12WAS
Nitrogen N (kg/ha)						
0.0	3.71	6.21c	4.38b	3.06	9.24c	5.70b
50	4.34	9.25a	4.76b	4.49	12.76a	4.06b
100	4.13	7.51b	5.02ab	4.19	10.89b	4.89b
150	3.24	8.64ab	8.81a	3.34	10.93b	8.73a
SE±	0.780	1.440	1.243	0.781	0.032	0.016
Intra-row spacing (cm)						
20	4.53	7.73b	4.35b	4.60	10.59b	4.16c
30	3.50	7.73b	7.49a	3.46	10.05b	8.37a
40	3.49	8.83a	5.40ab	3.82	12.23a	5.01b
SE±	0.675	1.080	0.932	0.602	0.024	0.012
Interaction	NS	NS	NS	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT
NS = Not significant

Table 3: Effects of nitrogen rates and intra-row spacing on total leaf yield of Moringa atSamaru and Maigana in 2015 wet season

	Total leaf yield (kg/ha)		
Treatments	Samaru	Maigana	Combined
Nitrogen N (kg/ha)			
0	7545c	5633d	6389d
50	8869b	9042b	8955b
100	8304b	8002b	8153c
150	11669a	11291a	11480a
SE±	429.23	394.32	183.85
Intra-row spacing (cm)			
20	8833b	8155b	8493a
30	9801a	8857a	9329a
40	8657c	8464b	8560b
SE±	321.92	295.74	137.89
Interaction	NS	NS	NS

Means followed by different letter(s) are significantly different at 5% level using DMRT
NS = Not significant

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Growth Medium and Soil Amendment Type and Rate on Seedling Growth Responses of African Star Apple (*Chrysophyllum albidum*)

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Abstract
Among the forest food trees that would require domestication for improved productivity and reduction of the long gestation periods are important fruit crops such as the African Star Apple (Chrysophyllum albidum). A study was conducted in 2017 at the Federal University of Agriculture Abeokuta, Nigeria to determine the growth responses of C. albidum seedlings to growth medium and fertilizer type/rate. The experiment was a 3 x 9 factorial arranged in a Completely Randomized Design (CRD) and replicated three times. The treatments included growth medium (sandy, loamy and clayey) and fertilizer type/rate (organic fertilizer at 5, 10, 15 t/ha poultry manure (PM) and inorganic fertilizer types/rates at 150, 250 and 500 kg/ha NPK 15:15:15 and the integrated fertilizer (5 t/ha PM + 150 kg/ha NPK and 10 t/ha PM + 150 kg/ha NPK) while the unfertilized (0 t/ha) served as control. The results showed that soil types had no significant effect on the growth of C. albidum seedlings from juvenile stage to vegetative stage. Among the fertilizer types the 250 kg/ha NPK significantly improved plant height, canopy spread, stem girth, number of leaves compared to other fertilizer types/rates. In conclusion, C. albidum can be cultivated on any type of soil and will need 250 kg/ha NPK fertilizer rate as optimum rate for plant growth.

Keywords: *African Star Apple, growth responses, growth medium, fertilizer type/rate, nutrient uptake, proximate content.*

INTRODUCTION

Chrysophyllum albidum (Linn), also known as African star apple is one of the eighty species of the family Sapotaceae (Adebayo *et al.,* 2011). Among the forest food trees species its natural occurrences is diverse with Eco zones in Uganda, Nigeria and Niger Republic (Bada, 1997). In Nigeria it is widely spread in lowland tropical rain forests where fruiting commences from the month of July and ripen between December and March (Ige and Gbadamosi 2007). Across Nigeria, it is generally regarded as a plant with diverse ethno-medicinal uses and is known by several local names (Amusa *et al.,* 2003), such as African star apple, agbalumo (Yoruba language) and udara (Igbo language) in Nigeria. The fruit is dark green in colour when unripe but turns into yellowish orange as it ripens and when over ripe turns to rusty orange.

The fruit is a berry which contains fleshy pulp and in most cases five hard seeds. The fleshy pulp of the fruit is eaten especially as snacks, while the exocarp is chewed by some to form stable chewing gum. The fruit has a very high content of ascorbic acid with 1000 to 3,300 mg of ascorbic acid per 100 g of edible fruit or about 100 times that of oranges and 10 times that of guava or cashew (Amusa *et al.,* 2003). Apart from its food and nutraceutical properties may therefore be harnessed for pharmaceutical excipient purposes by indigenous industries to further improve its economic value, stop the wastages that are currently prevalent and encourage large scale farming of the plant and this will be a source of employment for the teaming youths of West Africa (Okoye and Ndiwe, 2016). Several other components of the tree include the roots and leaves which are

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used for medicinal purposes (Adewusi, 1997), the bark as a remedy for yellow fever and malaria while the leaves also are used as emollients and for the treatment of skin eruption, diarrhoea and stomach ache (Adisa, 2000). Eleagnine, an alkaloid isolated from *C. albidum* seed cotyledon has been reported to have anti-nociceptive, anti- inflammatory and antioxidant activities (Idowu *et al.,* 2006).

Domestication efforts should target raising trees that produce fruits with good taste, high fruit pulp mass and big seeds/kernel. The strong and positive correlation identified between fruit weight and pulp weight as well as between fruit weight and seed/kernel weight for *C. albidum,* is an indication that bigger fruits will result in higher fruit pulp and larger seed/kernel (Atangana *et al*., 2002). In addition to pulp taste (sweetness), pulp weight and seed/kernel weight are some of the desirable commercial (market) traits for *C. albidum*. Thus, increasing fruit size will inadvertently lead to higher market values as well as higher income and livelihood for farmers and traders. Domestication through selection, vegetative propagation and improved production methods of multiple-trait of superior phenotypes is unlikely to be able to combine good fruit and good kernel characteristics within cultivars.

Fruit trees constitute important biological resources in many agro ecological systems and forest ecosystems all over the world. The assertion is evident by the fact of these tree species long time economic and ecological impacts in nature. Fruits are full of nature's rich essential nutrients, antioxidants and health benefits for ready use by humans (and other animals) without alternation in most cases, unlike vegetables and other edible agricultural/horticultural produce that may require necessary pre-treatments, like heating, sometimes before consumption (Rathore 2003; Kulnlein et al., 2009; Lapeña et al., 2014). The tropics, more than any other region of the world, is endowed with great diversity of fruit tree species that have provided humans with basic food and nourishment for ages since the domestication of beneficial wild plants (crops species). Tropical continents of the world possess rich variety of fruit trees with about 1000 species identified in Americas, 1200 species in Africa and 500 species in Asia (Paull and Duarte 2011; Sthapit et al., 2012). Although only relatively few fraction of these diversities are marketed worldwide, the diversities are nature's inestimable assets for the livelihoods of local people throughout the tropical regions.

In contrast to the noted diversity of fruit trees, only 10 annual cereal grains, pulses and oil seeds dominate 80% of the world agronomic fields. At present, wheat, rice and maize cover half of the world's croplands, while adding other annual gains and pulses accounts for up to two-third of all arable land in the world (Sthapit *et al.,* 2012; Jaramillo *et al.,* 2011). Also despite the fact that more than 90% of fresh fruit produce are consumed locally, the importation demand for tropical fruits has been on steady increase globally in the past few decades. According to FAO (2010), there is a great potential for growth of the fruit produce in the international markets due to the increasingly health consciousness and much hyped nutritional awareness about the consumption of more fresh fruits as well as vegetables in people's diets.

According to the authors (Grace *et al.,* 2008) in PROTA report, Tropical Africa comprised of 48 countries which are distributed across the various sub-regions of the continent. These sections of the continent are diverse in their climate, soil, topography and vegetation, which invariably influence the array and distribution of African floristic diversity. Tropical Africa sub-regions are home to many valuable fruit tree species whose

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potentials have not been fully realized. A good number of these fruit species have remained rather of local importance, and are yet to be domesticated. However, tangible economic produce are been harvested from their wild and or protected volunteer stands in home gardens, farmlands and forest reserves (Okigbo 1997; Meregini 2005). Following PROTA reports (Meregini 2005; Bosch et al., 2002), Tropical Africa has 477 edible fruit and nut species (including both indigenous and introduced naturalised ones) grown across its landscape. Attempts to identify and compile some of these local fruit commodity species that had their roots in Tropical Africa sub-regions, with regards to the species origin and natural distributions. The list should not be seen as exhaustive, since some of the IFT also yield other valuable products like timber and medicine for which they are sometimes treated as more of forest trees or medicinal plants than orchard species.

According to the National Academy of Science (2008), fruit production in Africa at present has been dominated by such species introduced from tropical Americas and Asia. These introduced species, including Banana, *Citrus* spp, Mango, Papaya, and Pineapple among others have also constituted bulk of international trade on tropical fresh fruit produce and processed fruit products. These and other adapted exotic tropical fruit crops which were already improved through horticultural selection and breeding, arrived on the African continent centuries ago and increasingly displaced the indigenous fruit species that had fed African for millennia. Moreover these introduced species received the support of colonial powers who wanted familiar crops that were highly economical to cultivate. Consequently, most of these introduced fruit species rather than the indigenous species were grown and established in orchards and plantations for large scale production and distribution. Thus, the IFT known to the local people continued their downward spiral of dwindling cultivation and knowledge without research investment and improvement. In fact, until recently, most of the researchers in horticultural crops production in Nigeria for example still inadvertently show preferences for detailed research work on introduced fruit species over the indigenous species, according to a recent survey (Ogbu and Ibekwe, 2013).

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Park and Garden Nursery Unit of Federal University of Agriculture, Abeokuta, Ogun State, Nigeria (latitude 7°15' N, Longitude 32° 5' E and altitude 100m above sea level). The site experience an annual mean temperature ranging from 24.2°C to 32.9°C, average rainfall amount 924.2-1,465.5 mm and relative humidity 80.3-81.5% (National Bureau of Statistics, 2011). The pre-cropping physical and chemical properties of the soils used as described in Table 1, revealed that % N was moderate in sandy and clayey soils but high in loamy, Av. P (mg/kg), was high in soils with a trend of loamy>sandy>clayey, K (cmol/kg) was high also albeit with a trend of clayey>loamy>sandy, % org. carbon and % org. matter was generally low with a trend of loamy> clayey >sandy (Sobulo and Osiname, 1981). For the manure, the nutrient elements N, P and K and both % org. carbon, % org. matter were high. The implication was that for low nutrient status a full dose fertilizer is required, for moderate value and rating a maintenance fertilizer required, and for high value and rating no fertilizer required.

Experimental Design

The experiment was a 3 x 9 factorial arranged in a Completely Randomized Design (CRD) and replicated three times.

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The treatments included growth medium (sandy, loamy and clayey) and fertilizer type/rate (organic fertilizer at 5, 10, 15 t/ha poultry manure (PM) and inorganic fertilizer types/rates at 150, 250 and 500 kg/ha NPK 15:15:15 and the integrated fertilizer (5 t/ha PM + 150 kg/ha NPK and 10 t/ha PM + 150 kg/ha NPK) while the unfertilized (0 t/ha) served as control.

Experimental Procedures

20 kg of each air dried and sieved sandy, loamy and clay soil was weighed into 27 experimental pots (i.e 20kg of each soil in 10pots). The organic manure treatment was mixed with the soil at the point of bagging while the inorganic was added one week after transplanting of the seedlings.
Seedlings of the same size and age were sorted and graded before being planted to reduce experimental error that may result from seedling size or age variation. Wetting was done to field capacity every 2days and weeds were removed by rouging as soon as weeds emerged from each pot.

Laboratory Soil Analysis

Routine analysis of pre-planting soil and poultry manure was carried out before the experiment to determine the basal nutrient available for plant use and at the end of the experiment the post planting soil analysis was done. 1 replicate of the seedlings was taken per treatment for tissue analysis. The analysis was carried out in the lab at COLNAS Federal University of Agriculture Abeokuta.

Data Collection

Data collection commenced 2week after planting when the plant has recovered from transplanting shock. Data were collected on vegetative growth parameters which included plant height, stem girth, number of leaves and tissue analysis of N, P, K, Ca, Mg, Mn, and Fe alongside the proximate content ;

Data Analysis

Analysis of variance (ANOVA) was carried out on each observation using the SAS (1990) software package and treatment means were separated using the least significant differences (LSD) (Steel and Torrie, 1980).

RESULTS

In the soil type, there was no significant difference observed in crop growth responses with respect to plant height, stem girth and canopy spread from 8 - 20 weeks after transplanting (WAT) (Table 2 & 3), however significant difference was observed in the number of leaf production at 20WAT of plant growth, where loamy soil followed by clayey soil although not different from one another both exhibited significantly more leaves compared to plants grown in sandy soil.
For the fertilizer type, although no significant difference was observed in plant height at the initial crop growth stage between the control and organic and inorganic fertilizer treated plants. At 8-12WAT, significantly taller growth responses was exhibited in plant supplied with 250 kg/ha although not different was observed in plants with 150 kg/ha while plants with 250 kg/ha exhibited significantly taller compared to plants treated as control, or supplied with manure and integrated fertilizer (ITF-L and (ITF-H). The plants with 150 kg/ha was nonetheless not different from plants with control, manure rates and integrated fertilizer.
The stem girth growth response showed an initial depression at 8WAT in plants with 500 kg/ha treatment compared to those with control, manure and integrated fertilizer rates, while after the no significant difference observed across board at 12WAT there was a switch in crop growth responses from 16-20WAT where significant thicker girth was exhibited in plants with inorganic fertilizer rate of 150, 250 and 500 kg/ha NPK at 8 and 12WAT compared to those with control, manure rates and integrated fertilizer rates.

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The leaf number production responses of *C. albidum* at 12-20WAT to fertilizer rate showed that the inorganic fertilizer using 150, 250 and 500 kg/ha and the lower integrated fertilizer rates consistently had significant influence on the leaf production with more leaves compared to fewer leaves of plants treated with manure and higher integrated fertilizer rates (Table 3). Although there was no significant difference between plants treated with 500 kg/ha and manure rates on the one hand and those with the manure and integrated fertilizer rates on the other hand at the 12-16WAT, nonetheless at the 20WAT plants with 250 kg/ha, 500 kg/ha and lower integrated fertilizer rates had more leaves but were not different from the plant treated with manure rates and the higher integrated fertilizer rates.

Except for the consistently wider canopy spread response exhibited in plants supplied with 5t/ha and in plants with 500 kg/ha at 12-20WAT, although no different was observed when compared with plants with 5 t/ha, 150 kg/ha, 500 kg/ha and the integrated fertilizer rates, the trend of response observed for canopy spread was not different from that exhibited in the stem girth responses.

Nutrient uptake from plant foliar analysis

higher nutrient uptake of P, K, Ca, Mg and Cu was observed in plants cultivated in loamy soil compared to lower responses from those in clayey soil, while significantly higher N was observed in plants with clayey soil and significantly higher Mn and Fe was observed in those with sandy soil (Figure 2). Plant in sandy soil was least in N, P, K, Ca, Mg and Cu while the clay was least in Mn and Fe. The plants supplied with 500kg/ha inorganic fertilizer had significantly higher nutrient uptake for the N, P and K, higher integrated fertilizer had significantly higher Ca, Mg and Mn uptake in plants although followed by 5 and 10 t/ha, and the 150 kg/ha in Mn uptake.

In the soil type, a higher fresh weight (FW) and dry weight (DW) was observed in plants cultivated in loamy soil followed by those in clayey soil but least in sandy soil (Figure 3). Highest proximate content was observed for plants in loamy soil in the crude protein content (CPC), Ash C, fat content (FC), starch and sugar contents, followed by plants in clayey soil in the FW, DW, FC, starch and sugar, but followed by sand in the CPC and Ash content. For the plants under fertilizer types, all the inorganic and integrated fertilizer treatments exhibited plants with higher FW and DW compared to those in manure rates. Plants in 250 kg/ha and integrated fertilizer types (low and high rates) had highest CPC, Ash C, FC, starch and sugar, followed by those in clayey soil in the FW, DW, FC, starch and sugar, but followed by sand in the CPC and Ash content.

DISCUSSION

The significant differences observed in growth responses of the *Chrysophyllum albidum* seedlings i.e. plant height, number of leaves, stem girth and canopy spread when cultivated in different soil types indicated similar responses of *C. albidum* can be grown on any type of soil. The application of 250kg/ha of NPK fertilizer significantly improved the plant height, stem girth, number of leaves and canopy spread compared to other rates. Which mean that 250kg/ha NPK possessed the required nutrient for optimum vegetative growth of *C. albidum* compared to other fertilizer rate. Olubode *et al*, 2012 had earlier reported the influence of higher N and P nutrient application rate in the attainment of budding size in citrus. Thus N is required for rapid plant growth and P for stem girth development. Hence, the quick release of both the higher inorganic application of 250 and 500 kg/ha NPK supported leaf production but complication

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from nutrient antagonism of 250 and 500 kg/ha and poor mineralization of integrated fertilizer rates hindered nutrient release. The optimum rate required for canopy spread was observed at 500 kg/ha while higher responses from plants treated with 5 t/ha PM, 150 kg/ha NPK and integrated fertilizer rates could be due to the early nutrient release as well as the influence on soil physical properties indicating influence of plant rooting activities. The various results observed indicated that in raising seedlings from juvenile stage to vegetative stage the slow release organic fertilizer did not have much influence on the plant, hence to obtain quicker growth responses would require the use of inorganic fertilizer at the rate of 250kg/ha NPK for increase plant height, canopy spread, stem girth and 150kg/ha NPK to increased number of leaves although no significant different was observed from the plant treated with 250kg/ha NPK and 150kg/ha NPK on the number of leaves. The organic manure applied to *C. albidum* seedlings took a long time to mineralize into the soil and for the plant to utilize its nutrient although the application of organic fertilizer has the advantage of increasing the soil organic matter.

Conclusion and Recommendation

In conclusion, the soil type had no significant effect on the growth of *C. albidum* seedlings from juvenile stage to vegetative stage. However, the 250kg/ha fertilizer rate had a consistent positive influence on the growth of the *C. albidum* seedlings. Therefore, *C. albidum* can be grown on any type of soil but will need soil amendment at optimum application rate of 250kg/ha NPK.

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Table 1: Physical and chemical analysis of soil and poultry manure

Parameter	Soil type			Manure
	Sandy	Loamy	Clayey	Poultry manure
pH	7.2	6.8	7.4	7.8
N (%)	0.105	0.206	0.129	4.489
Av. P (mg/kg)	32.673	41.361	26.716	26.615
Org. Carbon (%)	0.308	0.611	0.378	15.467
Org. Matter (%)	0.533	1.056	0.654	26.742
Ex. A (m Eq/100g)	0.1	0.2	0.4	0.3
Na (cmol/kg)	0.435	0.478	0.500	13.045
K (cmol/kg)	0.462	0.538	0.90	20.113
Ca (cmol/kg)	0.182	0.243	0.201	19.675
Mg (cmol/kg)	0.192	0.254	0.216	15.375
Sand (%)	91.42	52.46	31.87	ND
Clay (%)	0.00	5.87	62.78	ND
Silt (%)	8.58	41.67	5.35	ND

ND = not determined

Table 2: Plant height and stem girth responses of African Star Apple (*Chrysophyllum albidum*) to different soil type and fertilizer rate

Treatment	Plant height (cm)				Stem girth (cm)			
	8	12	16	20	8	12	16	20
Soil type (A)								
Sandy	18.11	18.67	19.11	19.62	0.06	0.07	0.08	0.10
Loamy	16.76	17.70	18.83	20.59	0.06	0.07	0.09	0.10
Clay	15.82	16.78	18.02	19.28	0.06	0.05	0.08	0.10
LSD	ns	Ns	ns	Ns	ns	Ns	ns	ns
Fertilizer Type (B)								
F1	17.76	18.51	19.66	20.38	0.06	0.07	0.08	0.10
F2	15.48	16.02	16.60	17.93	0.06	0.05	0.07	0.09
F3	16.14	16.97	17.37	18.62	0.05	0.06	0.06	0.07
F4	13.27	13.76	14.36	15.01	0.05	0.04	0.05	0.07
F5	18.47	19.23	20.23	21.70	0.07	0.08	0.10	0.12
F6	20.22	21.44	22.91	25.02	0.07	0.09	0.13	0.16

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F7	16.51	17.52	19.14	20.54	0.04	0.06	0.10	0.12
F8	14.08	14.64	15.52	16.51	0.05	0.06	0.07	0.10
LSD	3.43***	3.58***	3.78***	4.41***	*	ns	**	***
Interaction								
A x B	ns	ns	ns	Ns	ns	ns	ns	ns

S1 = Sandy, S2 = Loamy, S3 = Clay, F1 = Control 1 (0kg/ha), F2 = 5t/ha PD, F3 = 10t/ha PD, F4 = 15t/ha PD, F5 = Control 2 (150 kg/ha NPK), F6 - 250 kg/ha NPK, F7 = 500kg/ha NPK, F8 = 5t/ha PD + 150 kg/ha NPK

Table 3: Number of Leaves and canopy spread responses of African Star Apple (*Chrysophyllum albidum*) seedlings to different soil type and fertilizer rate

Treatment	Number of Leaves				Canopy spread (cm)			
	8	12	16	20	8	12	16	20
Soil type (A)								
Sandy	7.37	7.15	7.52	8.33	18.98	19.29	19.78	19.96
Loamy	7.81	7.41	8.48	10.67	17.73	19.27	21.76	23.67
Clay	7.48	7.07	8.07	10.33	16.30	18.24	20.13	22.07
LSD	ns	ns	ns	*	Ns	ns	Ns	ns
Fertilizer Type (B)								
F1	8.11	8.00	7.11	9.33	16.92	17.37	18.38	19.08
F2	7.00	6.56	6.78	8.56	17.13	18.86	21.33	23.44
F3	7.00	5.44	6.11	7.67	15.21	15.29	16.08	16.11
F4	6.78	4.67	5.67	7.11	12.81	12.78	14.75	15.72
F5	8.33	8.89	11.00	13.22	19.53	23.39	24.22	26.17
F6	9.56	10.22	10.67	12.00	25.02	26.64	28.26	29.83
F7	7.56	7.56	9.44	12.44	16.61	18.77	20.92	22.44
F8	6.78	7.11	8.78	10.22	16.33	17.58	21.22	23.72
LSD	ns	*	**	**	Ns	*	*	**
Interaction								
A x B	Ns	ns	ns	*	Ns	ns	Ns	ns

S1 = Sandy, S2 = Loamy, S3 = Clay, F1 = Control 1 (0kg/ha), F2 = 5t/ha PD, F3 = 10t/ha PD, F4 = 15t/ha PD, F5 = Control 2 (150 kg/ha NPK), F6 - 250 kg/ha NPK, F7 = 500kg/ha NPK, F8 = 5t/ha PD + 150 kg/ha NPK

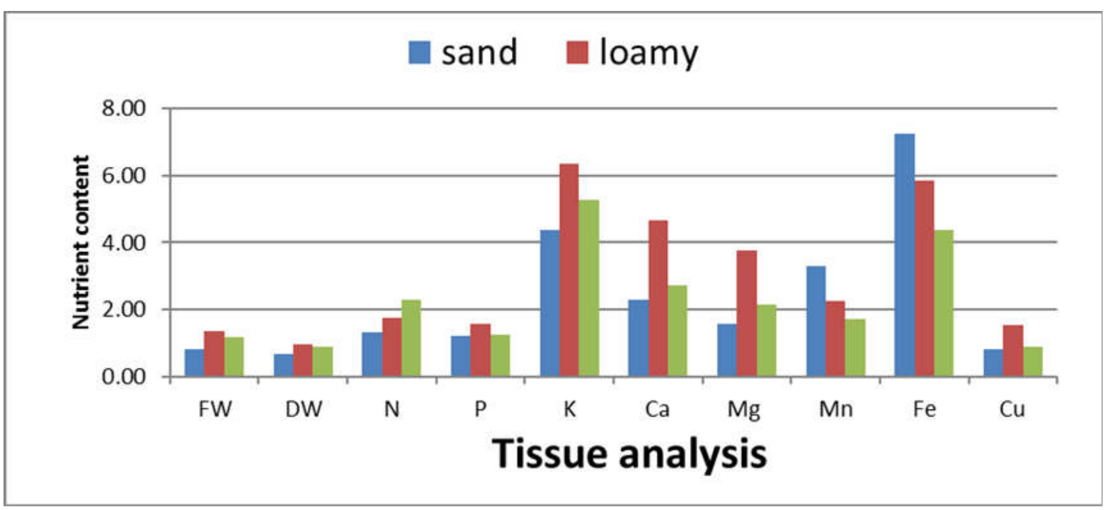

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Figure 2: Tissue analysis showing nutrient uptake of *Chrysophyllum albidum* cultivated in different soil types

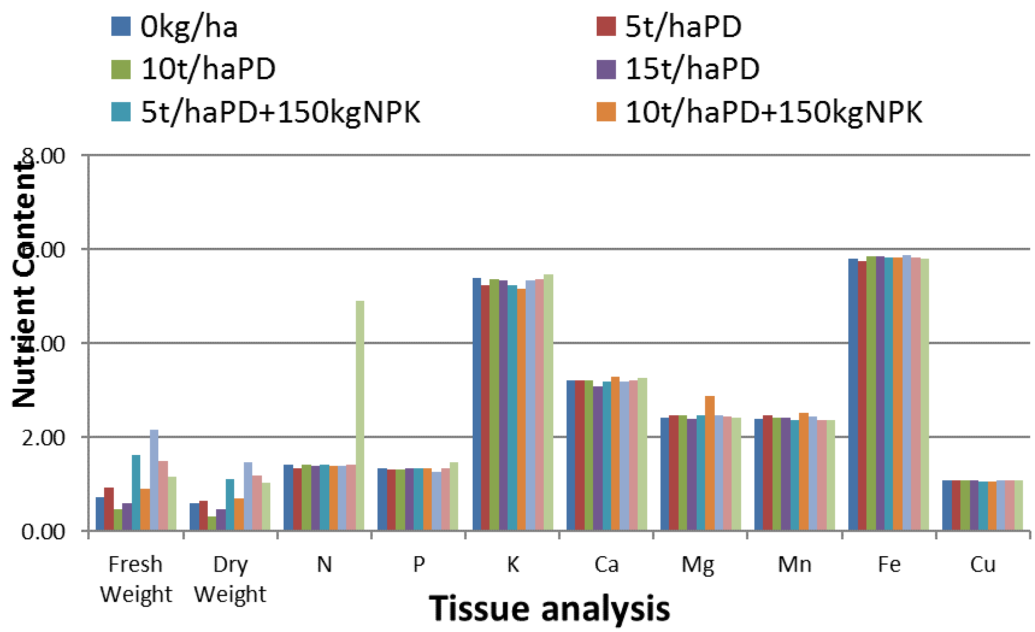

Figure 3: Tissue analysis showing nutrient uptake of *Chrysophyllum albidum* in response to applied fertilizer rates

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Response of Tomato (*Lycopersicon lycopersicum* L.) Varieties to NPK fertilizer Rates in the Sudan Savanna Agro-Ecological Zone of Nigeria

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Abstract
Field experiments were conducted during dry and wet seasons of 2016/2017 at the Teaching and Research Farm of KebbiState University of Science and Technology, to study the response of some tomato varieties to different rates of NPK (15:15:15) fertilizer. Treatments consisted of factorial combination of four (4) tomato varieties, Roma-VF, Tima, UC82B and Rio-grande and four NPK (15:15:15) rates at 0 (untreated control), 300, 600 and 900 kg NPK ha^{-1}. The experiment was laid out in a completely randomized block design, with three replications. The results showed that variety Roma-VF proved to be the best in terms of plant height (101.87cm) at 8 weeks after transplanting (WAT, number of leaves (103.00), weight of fruits per plant (1.10kg), mean fruits diameter (3.25cm) and fresh fruit yield (55.41t ha^{-1}), and with Tima in terms of plant height (92.64cm), number of leaves (83.92) and mean fruit weight (57.87g). Both variety Tima and Roma-VF produced greater mean fruits weight (57.87 and 50.04g, respectively) than UC82B (38.27) and Rio-grande (30.03g). Plant height, number of leaves and leaf area index throughout the growth period;number and weight of fruits per plant and mean fruit weight were higher with NPK rates of 600 and 900 kg ha^{-1}. Generally, the best growth and yield performance was by Roma-VF and Timavarieties coupled with the NPK rates from 600 and 900 kg NPK ha^{-1}. Based on the result of this study, it is concluded that the varieties Roma-VF and Tima coupled with NPK rates of 600 and 900kg ha^{-1} produced the best tomato growth and yield, hence recommended for tomato production in the study area.

INTRODUCTION

Tomato belongs to the family Solanaceae and is one of the most widely eaten vegetables in the world. The crop is reported to have originated from the Central and South America, extending from Mexico, Ecuador through Chile and from there it was introduced to Europe where it was improved further before reaching the United States and Asia (De Lannoy, 2001). In Nigeria, tomato is widely grown in Guinea Savanna region during the wet season and in Sudan Savanna during the dry season under irrigation (De Lannoy 2001). The world production of tomato in 2016 was 145.8 million metric tons with China leading with 41.9 million metric tons. In Africa, Egypt is the leading producer of the crop with production of 39.5 million metric tons and Nigeria is the fourth in Africa and leads in West African sub-region with an estimated output of 1.10 million metric tons and average yield of 10 t ha^{-1} (FAOSTAT, 2016). The yield of tomato in Nigeria generally low; the average yield in the Western part of the country being only about 5 t ha^{-1} and in the growing areas of Northern Nigeria is about20 t ha^{-1} (Phimmasone, 2011).

Tomato is a popular fruit vegetable in Nigeria, it can be eaten fresh or used in multiple of processed forms;but its yield is low compared with what is obtainable in the temperate zones, mainly due to differences in climate, use of inferior varieties as well as inadequate application of improved cultural practices such fertilizer application. African soil nutrient balances are often negative due to continuous cropping with low level of fertilizer inputs. This soil nutrient depletion is a major constraint to sustainable crop production and

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productivity (Mbah, 2006). For a crop like tomato that has shallow root system and yet requiring early flowering and fruits setting, it becomes necessary to provide adequate level of soil fertility through the use of fertilizers (Olaniyi*etal*., 2011); most especially as the responses of crops to nutrient absorption in the soil have been reported to be influenced by crop varieties(Nafiu*et al*., 2011).

In recognition of the increased costs of fertilizers as well as the growing concern for their potential environmental effect, their efficient and judicious use becomes an important aspect in tomato cropping system worth careful study. Since the soil of every environment has its own inherent fertility (Oyinlola and Junaidu (2012), the amount of nutrients needed to support a given crop depends on the local soil characteristics.The aim of this study therefore, was to determine the response of selected tomato varieties to different rates of NPK fertilizer.

MATERIALS AND METHODS

The experiment was conducted at theTeaching and Research Farm of Kebbi State University of Science and Technology, Aliero, Kebbi State during the 2016/2017 wet and dry seasons. The study area is situated atLatitude 12°18.64'N; Longitude 4°29.85'E; and at 262m above sea level located in the Sudan Savanna ecological zone of Nigeria. The area have a long dry season that is characterized by cool dry air (harmattan) that prevails from November to February and hot dry air extending from March to May. The location where the experiment was conducted was mainly used for cultivation of vegetable and cereal crops.The treatments consisted of factorial combination of four tomato varieties Roma-VF, Tima, UC82B and Rio-grande (sourced from National Horticultural Research Institute (NIHORT) Bagauda station, Kano State, Nigeria) and four rates of NPK 15-15-15 fertilizer applied at 0, 300, 600 and 900 kg ha^{-1}, and the experiment was laid out in a randomized complete block design (RCBD) with three replications. The land was ploughed and harrowed accordingly. Tomato seedlings were raised onfour sunken beds of 1.0 x 2m each adjacent to the main field. In the main field, plots of 3.0 x 2.5m (7.5m^2) were constructed making a gross plot of 12 x 37.5m (450m^2). The nursery beds were fertilized with 300kg NPK 15:15:15 after ploughing and harrowing. Each variety of the tomato was raised separately on the nursery bed by broadcasting lightly and raked under the soil to prevent drying off and thereafter, the beds were mulched and watered every day in the morning hours. The seedlings were hardened off by gradual removal of the mulch materials and by reducing the frequency of watering.Transplanting was done for the two trials after 34 and 37 days of sowing, respectively.

For the irrigated trial the seeds were sown and transplanted on 8th November, 2016 and 12th December, 2016, respectively; while for the rain-fed trial, the seeds were sown on 28th April 2017 and transplanted on 4th June 2017. The nursery bed was watered a day before transplanting which facilitated easy lifting of seedlings during transplanting. The seedlings were transplanted at the spacing of 40 x 50cm for both trials.Stakes of 0.75 - 1.2m height were driven in to the soil about 10cm to the side of the tomato plant. This was done within two weeks of transplanting; a thin white rope was used to secure the tomato to the stake.Plots were irrigated at intervals of 3 - 4 days within 1 - 8 weeks after transplanting (WAT), 6-7 days within 9 – 14WAT for the irrigated trial.Fertilizer application was carried out according to treatments at 0, 300, 600 and 900 kg ha^{-1}in two splits doses; at 2 and 5WAT, respectively.Manual (hoe) weeding was used to control weeds at 3, 6 and 9WAT.Cypermethrin® an insecticide

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formulation was sprayed four times at 6 – 9WAT for both trials and it was used according to recommended dosage rates for the control of vegetable insect pests.Harvesting was done by hand picking at 4-5 days' interval when fruits changed colour from green to pink or yellowish-red orange.

Data collected weresubjected to analysis of variance procedure using Statistical Analysis System (SAS^R, 2003). Means were separated using Duncan's Multiple Range Test (DMRT).

RESULTS

Plant height (cm)

Plant height at 8WAT as influenced by NPK rates and variety for irrigated and rain-fed trials during 2016/2017 growing season is presented in Table 1. For the irrigated trial at 8WAT, application of 900 kg NPK ha^{-1} resulted in significantly ($P \leq 0.05$) taller plants than only 300 kg ha^{-1} and the untreated control; but there was no significant difference ($P \geq 0.05$) between application at 900 and 600 kg NPK ha^{-1}. For the rain-fed trial, significantly ($P \leq 0.05$) taller plants were recorded with 600 kg NPK ha^{-1} than with 300 kg NPK ha^{-1} which was not significantly different ($P \geq 0.05$) from each other;and the shortest plants were recorded by the untreated control for irrigated trial and at 8WAT, Roma-VF produced significantly taller plant than only Rio-grande. For rain-fed trial, Roma-VF and Rio-grande produced taller plants than UC82B, but Tima was statistically similar ($P=0.05$) with Rio-grande.

Number of leaves

Number of leaves at 8 WAT as influenced by NPK rates and variety for irrigated and rain-fed trials is presented in Table 1. For the irrigated trial at 8 WAT, application of 600 and 900 kg NPK ha^{-1} produced significantlytaller plants than both 300 kg ha^{-1} and the untreated control. But in the rain-fed trial, application of NPK at all rates recorded taller plant than the untreated control.Effect of NPK and variety on number of leaves per plant of tomato in Irrigated and Rain-fed condition during 2016/2017 growing season is presented in Table 1. At all sampling periods, application of NPK at the rate of 900 kg ha^{-1} produce highest number of leaves per plant which was not statically different from ($P=0.05$)application rates of 600 kg ha^{-1}but were significantly different ($P \leq 0.05$) from application rates of300 kg ha^{-1} and the control treatment.On the other hand, higher numbers of leaveswere produced by Roma-VF variety than Tima, UC82B and Rio-grande in both irrigated and rain-fed trials. There was no significant interaction between the treatment factor in all the sampling periods in both irrigated and rain-fed tomato.

Number of fruits per plant

Number of fruits per plant for the irrigated trial, with fertilizer application rates of 600 and 900 kg NPK ha^{-1} produced significantly ($P \leq 0.05$)more number of fruits per plant than both 300 kg ha^{-1} and the untreated control. For the rain-fed trial, application of NPK at all rates significantly ($P \leq 0.05$) recorded more number of fruits per plant than the untreated control. On the other hand, for the irrigated trial Roma-VF and UC82B recorded more number of fruits when compared with Tima and Rio-grande varieties. Similarly, in rain-fed trial, Roma-VF and UC82B recorded more number of fruits than Rio-grande which in turn was higher than Tima. (Table 2)

Weight of fruits per plant

Weight of fruits per plant for both irrigated and rain-fed trial, was consistently and significantly ($P \leq 0.05$) heavier with the application of NPK at the rate of 600 and 900 kg ha^{-1} than 300 kg ha^{-1} and the untreated control; however, under rain-fed trial there was no significant difference ($P \geq 0.05$) between application rates of 300 kg ha^{-1} and the untreated control; while the interaction of fertilizer and varieties was

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significant.On the other hand, for both irrigated and rain-fed trial, variety Roma-VF, UC82B and Tima produced significantly heavier fruits per plant than Rio-grande. (Table 2); the interaction between fertilizer application rates and varieties was however not significant.

Mean fruits weight

Mean fruits weight as influenced by NPK application rates and varieties for irrigated and rain-fed trials during 2016/2017 growing season is presented in Table 3. For the irrigated trial, mean fruits weight was higher and significantly different ($P \leq 0.05$) with the application of 600 and 900 kg NPK $ha^{-1}$when compared with NPK rate of 300 kg ha^{-1} and the untreated control which were not significantly different ($p=0.05$) from each other. For the rain-fed trial, application rates of 600 and 900 kg NPK ha^{-1} recorded the highest mean fruit weights but was significantly different from application rate of 300 kg ha^{-1} and this produced higher and significantly ($P \leq 0.05$) fruit weights when compared to untreated control (Table 3).On the other hand, for the rain-fed trial, Roma-VF and Tima recorded statically ($p=0.05$) similar mean fruit weights which was higher than UC82B. The least mean fruit weight was by Rio-grande. For the rain-fed trial, Tima recorded higher mean fruit weights than Roma followed by UC82B with the least by Rio-grande variety (Table 3).

Fresh fruits yield

Table 3 also showed the mean fresh fruit yield as influenced by application of NPK rates and variety for irrigated and rain-fed trials during 2016/2017 growing season. For the irrigated trial, application of 600 and 900 kg NPK ha^{-1} produced significantly more fresh fruits yield than 300 kg ha^{-1} and the untreated control, which were not statistically different from each other. For the rain-fed trial, application of 600 and 900 kg NPK ha^{-1} resulted in more fresh fruits yield than 300 kg ha^{-1}. There was however, no significant statistical ($P \geq 0.05$) difference between application rates of 300 and 600 kg NPK ha^{-1}; but all the NPK rates were significantly different from the untreated control. On the other hand, for the rain-fed trial, Roma-VF and Tima varieties recorded statically similar mean fruit weights which were higher than UC82B. The least mean fruits weight was by Rio-grande. For the rain-fed trial, Tima recorded higher mean fruit weight than Roma-VF followed by UC82B with the least by Rio-grande.The interaction of NPK and variety on mean fruits weight, fruit yield were significant under both irrigated and rain-fed season; while there was no significant interaction in the mean fruit diameter produced under rain-fed season (Table 3).

DISCUSSION

Variety Roma-VF proved to be the best in terms of plant height, number of leaves, number and weight of fruits per plant, mean fruits diameter and fresh fruit yield, and with Tima in terms of plant height, number of leaves and mean fruit weight. The greater vegetativeness of variety Roma-VF could be due to its peculiar leaf arrangement, having more erect architecture which enables it display more leaves for effective photosynthesis. This is in harmony with the findings of Enujeke *et al.* (2013) that attributed the differences in growth characters of crop varieties to differences in distribution of leaf surface and crop canopy, leaf arrangement, differences in chlorophyll content and photosynthetic activities and activity of photosynthetic enzymes.

The greater performance of variety UC82B in terms of leaf area index (LAI) and number of fruits per plant could be attributed to larger individual leaf area it produced. This also explained the similarity in LAI and number and weight of fruits per plant between varieties Roma-VF and UC82B. The differences in growth

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and yield performance observed among the four varieties could be attributed to the genetic make-up of the varieties. Such genetically controlled variation among tomato varieties in term of growth and yield was reported by Olaniyi *et al.* (2010) and Samaila *et al.* (2011) who independently reported that genetic constitution of crop varieties influences growth and yield characters which they express. It is also similar to the findings of Muhammad and Singh (2007) that attributed the growth and yield differences in crop varieties to their production during the right season and in suitable agro-ecology.

Both Tima and Roma-VF varieties produced greater mean fruits weight than UC82B and Rio-grande. This could be due to the ability of Tima and Roma-VF to partition photosynthetic materials to economic yield. This is similar to the findings of Akanni (2005), Akanbi *et al.* (2003) who attributed the yield differences in crop cultivars to differences in partitioning of photosynthetic materials towards economic yield. It is also in harmony with the findings of Olaniyi*et al.* (2010) who attributed the differences in yield and its components between crop genotypes to variations in genetic structure, mineral concentration and potentials to transport photosynthetic materials within plants.

The greater mean diameter expressed by Roma-VF over Tima and Rio-grande varieties was due to the fruits shape and size. The fruits of Roma-VF are morphologically pear shaped and relatively bigger than the other three varieties. This could also be linked to genotype characteristics.

Plant height and number of leaves produced throughout the growth period were highest with fertilizer rate of 600 - 900 kg NPK ha^{-1}. The response of LAI to higher fertilizer rates of 900 kg NPK ha^{-1} as the crop ages could be attributed to nutrient supply, irrespective of fertilizer ratesand also to the nature of the fertilizer. The half dose applied as basal application, together with the inherent soil nutrient was able to nourish the crop for early growth. More so, the second fertilizer dose maintained the growth trend up to about fruiting stage. That could be the reason why higher fertilizer rates of 900 kg NPK ha^{-1} were needed for maximum growth at a later period of the crop's life cycle. Oyinlola and Junaidu (2012) and Samaila *et al*. (2011) suggested application of half of N at planting to ensure a uniform establishment, and then using frequent light application of N for the rest of the season in order to maintain vegetative growth and rapid fruit setting. Number and weight of fruits per plant and mean fruit weights were highest with NPK rates of 600 – 900 kg ha^{1}. The similar response of number and weight of fruits per plant; mean fruit weight and yield to NPK rates was due to the highly significant correlations of these characters to the final fresh fruit yield.

Nitrogen was largely known to enhance vegetativeness, but production, deposition and translocation of dry matter are believed to be collective functions of N, P and K (ref.). Since N content of fertilizer in these trials doubles the quantity of both P and K, application of 600 kg NPK ha^{-1} may supply adequate N for maximum leaf area, but inadequate for maximum dry matter production. Therefore, application of the highest fertilizer rate of 900 kg NPK ha^{-1} supplies reasonably adequate quantities of P and K for optimum dry matter production. This is in agreement with Isah*et al*. (2015) who attributed the growth and yield parameters of tomato to the level of plant nutrient availability. Nafiu*et al*. (2011) and Shuka*et al*. (1993) reported that tomato requires N, P, K, Mg, Ca and Na for good production and stressed that these nutrients are specific in function and must be supplied to the plant

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at the right time and in the right quantity. Uzo (1971) also emphasized on the satisfactory balance of N, P, and K nutrient elements for good production of tomato.

It was also observed that there wassignificant response of plant height, number of leaves, weight of fruits per plant, mean fruit weight and fresh fruit yield to the interaction of NPK rate and variety have clearly indicated the dependence of tomato genotypes to its edaphic environment for manifestation of their full potentials in terms of growth, development and yield as reported by Nafiu *et al*. (2011). Varieties Roma-VF, Tima and Rio-grande attained maximum plant height at NPK rates of 900 kg ha^{-1} while UC82B reach maximum plant height at NPK rates of 300 kg ha^{-1}for the irrigated while Tima, UC82B and Rio-grande reach maximum plant height at NPK fertilizer rates of 600 kg ha^{-1} for the rain-fed trial. Roma-VF, Tima and UC82B attained maximum leaf area index at NPK rate of 600 kg ha^{-1}, while variety Rio-grande attained similar performance at higher rate of 900 kg ha^{-1}. The similarity between Roma-VF, Tima and UC82B in attainment of maximum leaf area index was due to the profuse nature of the varieties in terms of leaf production.

Number of fruits and mean fruit weight were significantly influenced by fertilizer interactions. All the varieties produced maximum number and weight of fruits at NPK rate of 600 and 900 kg ha^{-1}. This trend could be attributed to the rate at which fertilizer dissolved and absorbed by the plant hence limiting its availability for crop uptake (Muhammad and Singh, 2007). Roma-VF and Tima attained maximum yield at fertilizer rate of 600kg NPK ha^{-1} while UC82B and Rio-grande attained maximum yield at fertilizer rate of 900kg NPK ha^{-1} though, Rio-grande also attained maximum yield at fertilizer rate of 600kg NPK ha^{-1} at par with Roma-VF and Tima. The rate of interaction of all the varieties with the rate of fertilizer application with the level of availability and assimilation determine the yield of each variety.

CONCLUSION

Based on the results of this study, it could be concluded that the varieties Roma-VF and Tima coupled with NPK rates of 600-900 kg ha^{-1} produced the best growth and yield in the study area.

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Table 1: Plant height and number of leaves of tomato as Influenced by Variety and NPK rates in Irrigated and Rain-fed conditions in 2016/2017 Growing season

Treatment	Plant Height (cm) 8WAT		Number of leaves 8WAT	
	Irrigated	Rain-fed	Irrigated	Rain-fed
NPK (kg ha^{-1})				
0 (Control)	70.34c	21.98c	66.67ab	13.92b
300	73.57bc	33.82b	63.83b	23.68b
600	84.52ab	42.29a	82.92ab	38.67a
900	89.33a	39.07ab	85.25a	40.32a
SE±	4.17	2.32	6.33	3.65
Varieties				
Roma–VF	88.36a	40.16a	99.25a	37.35a
Tima	78.03ab	32.44bc	78.08b	24.66b
UC82B	76.82ab	28.33c	68.33bc	27.20ab
Rio-grande	74.55b	36.22ab	53.00c	27.37ab
SE±	4.17	2.32	6.33	3.65
Interaction				
NPK x Var	NS	NS	NS	NS

Means followed by the same letter (s) in a treatment group are not significantly different at 5% probability.

Table 2: Number and Weight of Fruits per Plant of tomato as influenced by variety and NPK rates in irrigated and rain-fed conditions in 2016/2017 growing season

Treatment	Number of Fruits per Plant		Weight of Fruits per Plant (kg)	
	Irrigated	Rain-fed	Irrigated	Rain-fed
NPK(kgha^{-1})				
0 (Control)	13.58b	13.50b	0.43b	0.33b
300	14.96b	17.99a	0.50b	0.54ab
600	20.51a	16.98a	0.98a	0.64a
900	22.33a	17.61a	0.99a	0.69a
SE±	2.090	1.530	0.211	0.130
Varieties				
Roma-VF	22.15a	24.58a	1.10a	0.79a
Tima	15.73b	13.58c	0.85a	0.78a
UC82B	24.20a	25.33a	0.92a	0.76a
Rio-grande	14.00b	19.88b	0.42b	0.31b
SE±	2.090	1.530	0.211	0.130
Interaction				
NPK x Var	*	*	NS	NS

Means followed by the same letter (s) in a treatment group are not significantly different at 5% using DMRT

Table 3: Mean fruit weight (g), mean fruit diameter (cm) and fresh fruit yield (t ha^{-1}) of tomato as influenced by variety and NPK rates in irrigated and rain-fed conditions in 2016/2017 growing season

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Treatment	Mean Fruit Weight (g)		Mean Fruit Diameter (cm)		Yield (t ha^{-1})	
	Irrigated	Rain-fed	Irrigated	Rain-fed	Irrigated	Rain-fed
NPK(Kgha^{-1})						
0 (Control)	32.09b	25.03c	2.86	2.92	21.78b	16.89c
300	33.95b	30.25b	2.72	3.07	25.39b	27.20b
600	47.96a	38.16a	2.75	2.96	49.18a	32.39ab
900	44.64a	39.28a	2.74	3.15	49.84a	34.58a
SE±	2.030	2.203	0.080	0.130	3.313	3.432
Varieties						
Roma – VF	52.28a	50.04a	2.83a	3.07ab	45.95a	55.41a
Tima	57.87a	54.15a	2.94a	3.25a	39.29ab	42.58b
UC82B	28.41c	38.27b	2.40b	2.87b	35.98b	46.30b
Rio-grande	20.09d	30.03c	2.90a	2.92b	19.96c	21.02c
SE±	2.030	2.203	0.080	0.130	3.313	3.432
Interaction						
NPK x Var	*	*	*	NS	*	*

Means followed by the same letter (s) in a treatment group are not significantly different at 5% using DMRT

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Effect of Organic Manure and Nitrogen Fertilization on the Growth and Yield of Sesame (*Sesamum indicum* L.) in Gombe, Nigeria

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Abstract
Field experiment was conducted during the 2017 rainy season (June to September) at the Teaching and Research Farm, Federal College of Education (Technical), Gombe to evaluate the effect of organic manure and nitrogen fertilization on the growth and yield of sesame. Treatments consist of four levels of organic manure (0, 5, 10 and 15 t/ha) and four levels of nitrogen fertilizer (0, 60, 120 and 180 kg/ha). Cow dung and Urea were sources of organic manure and nitrogen respectively. The experiment was laid out in Randomized Complete Block Design (RCBD) replicated three times. Parameters measured included plant height, number of leaves, number of branches, number of capsules per plant, length of capsule and total yield. Data collected on various parameters were subjected to statistical analysis of variance (ANOVA) using Genstat Discovery Edition 2013. Means were separated using least significant difference (LSD) at 5 % probability level. The results showed significant effect of organic manure and nitrogen on plant height, number of branches, number of capsules per plant and yield. Application of 15 t/ha and 120 Nkg/ha recorded highest values of 95.70 cm, 6.8, 52 and 108 kg for plant height, number of branches per plant, number of capsules per plant and yield respectively, but not significantly different from those of 10 t/ha and 120 kg N/ha. The number of leaves and length of capsules were not significant. Since application of 10 t/ha and 120 Nkg/ha gave better performance in most of the parameters measured and was therefore recommended for optimum production of sesame in the area.
Keywords: Organic manure, nitrogen fertilizer, growth, yield, sesame

INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the oldest crop plants planted in warm and arid areas all around the world. Its seed contains approximately 50% oil and 25% protein (Burden,2005). Worldwide production of sesame is estimated at 3.09 million tones predominantly from Asia and Africa with an average yield of 471.2kg ha-1. Sesame has gained considerable importance in Nigeria due to its economic value and especially export potential. In Nigeria, Sesame is produced mainly in the savanna agro-ecological zones extensively by small holders using manual labour and limited inputs, on relatively poor soils thereby resulting in low average yield of 300 kg ha-1 compared with 1,960 kg ha-1 in Venezuela, 1083 kg ha-1 in Saudi Arabia, 517 kg ha-1 in Ivory Coast and 510 kg ha-1 in Ethiopia (Abubakar *et al*., 1998).Integrated use of nutrients through organic and inorganic sources in a balanced proportion for sustainable production of sesame was emphasized among others Hegde (1998) and Deshmukh *et al*. (2002). Narkhede *et al*. (2001) reported that application of nitrogen, phosphorous and potassium 40 kg N, 30 kg P2O5 and 20 kg K2O ha-1 in combination with the application of FYM 10 t ha-1 produced significantly more seed yield of sesame than the application of inorganic fertilizers NPK (40 kg N, 30 kg P_2O_5 and 20 kg K_2O /ha) applied in combination with different levels of micronutrients and control.

In an experiment on integrated nutrient management insesame, Duhoon *et al*. (2004) reported that sesame yield was significantly improved by application offertilizers in combination with organic manures in different soil types (Vertisols, Alfisols andInceptisols). Among the management practices, planting methods and fertilization are the mostimportant

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factors in determining yield of sesame (Subramanyan and Arulmozhi, 1999).Fertilizers are not applied to sesame even in major sesame growing areas of Nigeria (Shehu *et al.* 2010). However there are studies where plant height and dry matter of sesame has increased significantly with increase nitrogen up to 150 kg ha -1 (Kalaiselvan *et al*. 2001).This study, therefore, seek to evaluate the effect of nitrogen fertilization and organic manure on the growth and yield of sesame.

MATERIALS AND METHODS

Field experiment was conducted during the rainy season of 2017 at the Teaching and Research Farm of Federal College of Education (Technical), Gombe (Latitude 10^0 15'N and Longitude 11^0 10'E and 380 m above sea level) located in the sudan savanna of Nigeria. The experiment consisted of four levels of nitrogen (0, 60, 120 and 180 kg N/ha) in the form of urea and four levels of cow dung (0, 5, 10 and 15 t/ha). The 16 treatment combinations were laid out in a randomized complete block design replicated three times. The net plot size was 20.25 m^2 (4.5 m x 4.5 m). The experimental area was clearedthen followed by construction ofridges and thereafter field was marked into plots and blocks. The plots were separated by 1.0 m unplanted boarder while replications were separated by 2.0 m unplanted area. The four levels of cow dung were incorporated into the ridges according to the treatment after landpreparation and left for two weeks before sowing. Sowing was done at a spacing of 10 cm x 60 cm. Half of the nitrogen levels were applied at 3 weeks after sowing (WAS) while the remaining half was applied at 6 WAS. The sesame cultivar used was 'Nomeri'. Manual hoe weeding was done at 3, 6, and 9 WAS to keep the experimental plots weed-free. Growth parameters like plant height, number of branches and leaves per plant were taken from five randomly selected tagged plants in each plot and the mean recorded. Yield data per plant such as number of capsules per plant, capsules length and seed yield per plant, were collected from five randomly selected tagged plants in each plot and the mean recorded. Plants from each plot were gathered into a sack to dry so as to minimize seed loss when capsule dehisces. When the harvested plants were adequately dry, the sacks were gently beaten with sticks in order to release all the seeds from the capsules. The seeds were then separated from the chaff by winnowing. The entire plants in the net plot were used to obtain the seed yield per hectare.

The data collected were subjected to analysis of variance (ANOVA) using Genstat Discovery Edition 2013 and significant differences among the treatment means were evaluated using Least Significant Difference (LSD).

RESULTS

Physical and chemical analysis of the soil (Table 1) revealed that the texture is loamy sand with sand, silt and clay contents of 86.72, 5.28 and 8% respectively. The soil is slightly acidic, low in organic carbon, N, P and K but medium in Ca, Mg and Na. Analysis of the cow dung indicated high values of organic carbon, N, P, K, Ca, Mg and Na than the soil of the experimental site (Table 1).

The effect of nitrogen fertilization on sesame height was significant ($p \leq 0.05$) only at 4 WAS where nitrogen rate of 180 kg N/ha produced tallest plant (5.33 cm), followed by those that received 120 kg N/ha with 4.00 cm while the control gave the least value of 3.83 cm which was at par with those applied 60 kg N/ha (Table 2). Cow dung significantly affected plant height at 8 WAS with cow dung applied at 15 t/ha recorded the tallest plant with 44.33 cm, followed by those that received 10 t/ha with 41.92 cm, while 0 t/ha gave the shortest plant with 32.75 cm.

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Result of the effect of nitrogen fertilization on number of leaves per plant showed significant (p≤0.05) effect at 12 WAS as shown on Table 3. Plants that received nitrogen rate of 120 kg N/ha produced more leaves than others with the value of 100.90 leaves, followed by those applied 180 kg N/ha with 96.67 leaves while the least values of 87.42 and 86.17 leaves were obtained from plants that received 60 and 0 kg N/ha respectively (Table 3).

Nitrogen fertilization and organic manure showed no significant (p≤0.05) effect on the number of branches per plant throughout the sampling periods (Table 4). The effect of nitrogen fertilization and organic manure on the number of capsules per plant showed highly significant (p≤0.01) as shown on Table 5. Plants that received nitrogen rate of 120 kg N/ha produced highest number of capsules per plant with 43 capsules followed by those applied 60 kg N/ha with 18.33 capsules while the least number of capsules were obtained from plants applied 180 and 0 kg N/ha with 11.83 and 8.33 capsules respectively. The number of capsules per plant increased as more cow dung was applied, plants with cow dung rate of 15 t/ha recorded highest number of capsules per plant with 21.67 capsules, while the least number of capsules per plant of 18.42 was obtained from plants applied 0 t/ha. Capsules' length increased as more nitrogen rates increase to a point. Longest capsules of 3.08 cm were recorded with plant applied nitrogen rate of 120 kg N/ha followed by those applied 60 and 180 kg N/ha with 2.60 cm and 2.32 cm capsule lengths respectively (Table 5). Nitrogen fertilization and organic manure significantly (p≤0.05) affected total seed yield of sesame as shown on Table 6. Plants that received nitrogen rate of 120 kg N/ha produced highest number of total seed yield of 930.17 kg/ha, followed by those applied 60 kg N/ha with 883.33 kg/ha while least value of 666.70 kg/ha was from plants that received 0 kg N/ha. Similarly, sesame plants applied cow dung at 15 t/ha produced highest total seed yield with 1091.67 kg/ha followed by that received 10 t/ha with total seed yield of 954.15 kg/ha, while the least seed yields of 645.85 and 758.35 kg/ha were recorded from plants applied cow dung at 0 and 5 t/ha respectively.

DISCUSSION

The growth and yield parameters of sesame were significantly influenced with the application of nitrogen fertilizer and organic manure (cow dung). The response exhibited by sesame to nitrogen application as observed by increase in plant height, number of leaves and branches could be attributed to the ability of N in promoting vegetative growth and that as an important of chlorophyll, amino-acids and nucleic acid enhance plant's growth and development. This is in conformity with the findings of Okpara *et al*. (2007) and Haruna (2011) who reported significant increase in growth characters such as plant height, number of branches and leaves of due to nitrogen fertilizer application. Nitrogen application also increased yield parameters such as number of capsules per plant, capsules' length and total seed yield. This may be due to availability of nitrogen which enhance production and translocation of dry matter from source to sink (Akinrinde, 2006). This result is similar to the findings of Imayavarambam *et al*. (2002) that application of N increased number of capsules, plant height and seed yield. Organic manure also increased both the growth and yield parameters of sesame in this study. This may be due to beneficial effects of organic manure on soil fertility (Satyanarayana *et al*., 2002). Application of cow dung at 15 t/ha recorded high values of growth parameters but not significantly different from those that received 10 t/ha, while yield parameters were better at cow dung level of 10 t/ha.

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This findings agreed with those of Vaiyapuri *et al*. (2004) that application of organic manure at 10 t/ha gave optimum seed yield per hectare of sesame but contrary to those of Haruna and Aliyu (2012) and Teshome (2016) who recommended organic manure (poultry manure) of 5 t/ha for high seed yield in sesame.

CONCLUSION AND RECOMMENDATION

Results from this study show that growth and yield parameters of sesame were significantly increased in response to the application of nitrogen fertilizer and cow dung. Plant height, number of leaves, branches and capsules per plant increased with increase in nitrogen and cow dung application. High (120 and 180 kg N/ha) nitrogen application and 10 and 15 t/ha organic manure produced better growth and yield parameters in sesame. For economic reason, application of nitrogen fertilizer at 120 kg N/ha and organic manure (cow dung) at 10 t/ha is recommended for the farmers in Gombe for optimum production of sesame.

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Table 1: Physical and Chemical Properties of the Soil in the Experimental Site and Properties of the Cow Dung

	Values	
Parameters	Soil	Cow Dung
pH water	6.80	9.07
pH KCl	5.72	-
Organic Carbon (g/kg)	0.29	18.60
Total Nitrogen (g/kg)	0.05	1.36
Available P (mg/kg)	6.34	10.86
Exchangeable bases (cmol/kg)		
Calcium	2.06	3.24
Magnesium	0.53	0.34
Potassium	0.18	2.47
Sodium	0.24	0.54
Soil Texture (%)		
Sand	86.72	-
Silt	5.28	-
Clay	8.00	-
Textural Class	Loamy sand	

Table 2: Effect of Nitrogen fertilization and organic manure on sesame plant height (cm)

	Weeks after sowing (WAS)		
Treatment	4WAS	8WAS	12 WAS
Nitrogen levels (kg N/ha)(N)			
0	3.83	35.83	77.67
60	3.83	39.25	83.08
120	4.00	41.75	95.67
180	5.33	40.33	93.00
LS	*	NS	NS
LSD	0.618	6.590	16.390
Cow Dung (t/ha) ©			
0	4.03	32.75	85.25
5	4.12	38.17	85.92
10	4.33	41.92	86.33
15	4.42	44.33	91.92
LS	NS	*	NS
LSD	0.618	6.590	16.390
Interactions			
N x C	NS	NS	NS

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Table 3: Effect of Nitrogen fertilization and organic manure on Number of Leaves per Plant

	Weeks after sowing (WAS)		
Treatment	4WAS	8WAS	12 WAS
Nitrogen levels (kg N/ha)(N)			
0	5.25	33.92	81.08
60	5.67	36.58	90.25
120	6.08	39.58	100.90
180	6.33	37.33	96.67
LS	NS	NS	*
LSD	1.097	14.410	14.100
Cow Dung (t/ha) ©			
0	5.42	33.08	86.17
5	5.83	35.17	87.42
10	5.92	41.50	103.33
15	6.17	37.67	92.00
LS	NS	NS	NS
LSD	1.097	14.410	14.100
Interactions			
N x C	NS	NS	NS

Table 4: Effect of Nitrogen fertilization and organic manure on Number of Branches per Plant

	Weeks after sowing (WAS)		
Treatment	4WAS	8WAS	12 WAS
Nitrogen levels (kg N/ha)(N)			
0	2.08	3.83	5.33
60	2.17	4.17	5.42
120	2.25	4.67	6.75
180	2.25	4.58	5.92
LS	NS	NS	NS
LSD	1.018	1.045	1.228
Cow Dung (t/ha) ©			
0	1.67	4.00	5.42
5	1.75	4.25	5.58
10	2.42	4.42	6.75
15	2.92	4.58	5.67
LS	NS	NS	NS
LSD	1.018	1.045	1.228
Interactions			
N x C	NS	NS	NS

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Table 5: Effect of Nitrogen fertilization and organic manure on Number of Capsules per Plant (C/P), Length of Capsules (LC) and Total Seed Yield (TSY)

Treatment	C/P	LC (cm)	TSY (Kg/ha)
Nitrogen levels (kg N/ha)(N)			
0	8.33	2.28	666.70
60	18.33	2.60	883.33
120	43.00	3.08	930.17
180	11.83	2.32	791.70
LS	**	*	*
LSD	2.951	0.135	185.710
Cow Dung (t/ha) ©			
0	18.42	2.47	645.85
5	20.58	2.54	758.35
10	20.83	2.62	954.15
15	21.67	2.64	1091.67
LS	**	NS	*
LSD	2.951	0.135	185.710
Interactions			
N x C	NS	NS	NS

*,** denote significant effect at 5 and 1% probability levels; NS = Not significant; LSD = Least significant difference

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Elemental Characterization of Biochar of some Horticultural Crop Wastes

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Abstract
Biochar a black carbon-rich solid produced through pyrolysis or gasification is becoming important in soil fertility management when applied to the soil. Wastes (feedstocks) from horticultural crops and agricultural wastes that needed to be removed from our immediate environment could be converted to biochar. Thus, biochar from these wastes needed to be characterized to determine their nutrient quality before their eventual application to the soil. This study therefore characterized the biochar from some horticultural cropwastesto determine their nutrient status. Elemental characterization were carried out on biochar from five horticultural crop feedstocks - mango endocarp, citrus wastes, plantain stalk, pineapple peel and pineapple pulp. The feedstocks weredried and pyrolized at 300 C using a steel Pyrolizer. Laboratory analyses were carried out to determine the pH, nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), manganese (Mn), zinc (Zn) and copper (Cu) on the feedstocks and their biochar.The average feedstock ratio to Biochar is 2:1. Characterisation of the five Biochar indicated materials of alkaline level (pH of 8.0 - 11.0). The range of elemental level of the biochar'sare N (0.82 - 1.88 %), P (0.55 - 0.73%), K (1.39 - 11.12 %), Ca (0.07 - 4.36 %), Mg (0.23 - 0.60 %), Fe (0.07 - 1.64 %), Mn (185 – 280 mg/kg), Zn (30 – 3055 mg/kg) and Cu (0 – 35 mg/kg). The characterization indicates the potentials of the horticultural wastes as a promising organic fertilizer/soil conditioner material.

Keywords: *Horticultural crop wastes, Feedstock, Biochar, Soil fertility, Fertilizer*.

INTRODUCTION

Most tropical soils including those found in Nigeria, have serious physical and chemical constraints for sustainable crop production (Fagbenro, 2015). Biochar can reducethese constraints and reverse farmland degradation, support sustainable food production and create renewable biofuels. Biochar technology is a sustainable means by which biomass can be converted to organic fertilizer for farm use thereby increasing crop productivity. Wastes from horticultural crops abound all over our markets and communities, constituting a nuisance to the environment and a reservoir of vectors of diseases (Olufunmi et al., 2015). Conversion of these wastes to useful products, such as organic fertilizers, will help in cleaning up the environment, reduce occurrences of sickness and disease and become an opportunity for wealth creation (Olufunmi et al., 2015).Biochar is commonly defined as charred organic material, produced with the intent to deliberately apply to soils to sequester carbon and improve soil properties (Lehmann and Joseph, 2009). Biochar is produced through pyrolysis of C-based feedstocks (biomass) and is best described as a soil conditioner. Pyrolysis is the chemical decomposition of an organic substance by heating in the absence of or little oxygen. Actually a totally oxygen free condition may not be possible, therefore some amount of oxidation will still occur. The degree of oxidation of the organic matter is relatively small when compared to combustion where almost complete oxidation of organic matter occurs, and as such a substantially larger proportion of the carbon in the feedstock remains and is not given off as CO_2 (Verheijen et al., 2009). The status of biochar as a soil conditioner or fertilizer (organic) has generated some arguments. A school of thought agreed that it is a

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fertilizer since it contains appreciable level of major and minor nutrients as in organic fertilizer while another said that it is a soil conditioner since it cannot be added alone to the soil. Application of biochar to the soil influences various soil properties. Due to high specific surface area of biochar and because of direct nutrient additions via ash or organic fertilizer amendments, nutrient retention and nutrient availability were reportedly enhanced after its application (Glasser et al., 2002). Higher nutrient retention ability, in turn, improves fertilizer use efficiency and reduces leaching (Steiner et al., 2008). Biochar aids in the sorption of heavy metals such as lead (Pb), arsenic (As), Cadmium (Cd) and sorption of organic molecules like agricultural herbicides, pesticides and industrial contaminants (Cao et al., 2009). Stability of biochar carbon is intrinsic to its role as a significant carbon dioxide sink and amelioriation of climate change. Van Zwieten et al. (2009) proposedseveral mechanisms through which biochar can affect emissions of N_2O and CH_4 greenhouse gases. Awareness of the importance of biochar technology is increasing due to its many advantages to the environment, in waste managementand in increasing crop productivity. This study is therefore undertaken to manage horticultural crop waste through biochar technology with the intent of using the biochar as a soil amendment. The objectives of this study are to convert some horticultural crop wastes to biochar and to characterize the biochar's.

MATERIALS AND METHODS

Five (5) feedstocks - horticultural crop wastes (mango endocarp, citrus wastes, plantain stalk, pineapple peel and pineapple pulp) were collected and dried. Mango endocarp were collected from mango orchards of National Horticultural research Institute, Ibadan; citrus, pineapple peel and pulp wastes were from the fruit processing unit of the same institute and plantain stalk from markets within Ibadan. The feedstocks were afterward subjected to Pyrolysis (burning at 300 C using a steel Pyrolizer) for eight hours. Laboratory analyses were carried out on the dried wastes/feedstocks and their biochar for characterisation.The following parameters were determined – pH, N, P, K, Ca, Mg, Fe, Mn, Zn and Cu. pH was determined in distilled water (1:1). Nitrogen was determined by macro - Kjeldahlmethod (Amin and Flowers, 2004). Thereafter, an aliquot of the digest was taken and the N content determined by colorimetric Technicon auto analyser method with Labomed 20D spectrophotometer at 630 nm. Samples were analysed for their P, K, Ca, Mg, Fe, Mn, Zn and Cu contents according to the procedure outlined in Selected Methods for Soil and Plant Analysis Manual of International Institute of Tropical Agriculture, Ibadan (IITA, 1979). A 5.0ml Nitric/Perchloric acid mixture (ratio 2:1) was added into 0.2 g of each sample contained in a 25 ml conical flask and left overnight. The plant samples were heated until white fuming stage, the point at which 1.0 ml of hydrochloric acid/distilled water mixture (ratio 1:1) was added and heated for further 30 minutes. Distilled water was added to the digest and shaken before cooling down to room temperature to avoid formation of insoluble perchlorate compounds. The digest was washed into 50 ml volumetric flasks and made up to mark with distilled water. Total phosphorus was determined by vanadomolybdate yellow colorimetric method (A.O.A.C, 1970) while K, Ca, Mg, Fe, Mn, Zn and Cu was determined by Atomic Absorption Spectrophotometry method.

RESULTS AND DISCUSSION

Tables 1 and 2 below show the proportion of dried wastes (feedstock) to Biochar and range of feedstock and Biochar elemental characterization respectively. The average feedstock ratio to Biochar is 2:1 as can be deduced from Table 1. Characterisation of the five Biochar (Table 2) indicated materials of alkaline level. Biochar with the highest pH value was the citrus waste (11.0) and the lowest was pineapple peel (8.0). Application of the biochar's to acidic soils will help in raising the pH thereby making some nutrients,especially phosphorus available for plant use.The pH trend of the biochars in descending order was citrus wastes >plantain stalk > pineapple pulp> Mango endocarp> pineapple peel.Highest value of N (1.88 %), P (0.73 %), Ca (4.36 %) and Mg (0.60 %) were obtained on citrus waste while highest K (11.12 %) was on plantain stalk. Thehigh K (11.12 %)content of plantain stalkis a confirmation of its usage as a raw material for soap production. Elemental trend in the biochar's areN: citrus wastes > pineapple pulp> mango endocarp> pineapple peel>plantain stalk, P:citrus wastes =mango endocarp >plantain stalk>pineapple pulp= pineapple peel, K:plantain stalk >citrus wastes >pineapple peel>pineapple pulp>mango endocarp, Ca:citrus wastes >pineapple peel>plantain stalk>pineapple pulp>mango endocarp, Mg:citrus wastes >pineapple peel>plantain stalk>mango endocarp>pineapple pulp>, Fe:mango endocarp>citrus wastes > pineapple pulp>> pineapple peel>plantain stalk, Mn:pineapple peel>plantain stalk = citrus wastes >> mango endocarp>pineapple pulp, Zn:pineapple pulp>plantain stalk >citrus wastes > mango endocarp> pineapple peel, Cu:pineapple pulp>mango endocarp>citrus wastes = pineapple peel>plantain stalk. The nutrient levels of the biochar's were in most cases higher than that of the feedstocks which implies that there were no loss of nutrients during pyrolysis.

CONCLUSION

The conversion of the horticultural crops wastes into biochar removes the wastes from the environment thereby ensuring a cleaner environment. Furthermore, the volume of the wastes are reduced to one-third of the original while retaining the nutrient quality. In this form, application to the soil or crop are easier and more manageable.

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Table 1 Proportion of dried wastes (feedstock) to Biochar

Wastes	Dried (kg)	Biochar (kg)
Citrus	8.5	4.7
Plantain stalk	3.5	1.9
Mango endocarp	4.7	2.8
Pineapple peel	6.0	4.0
Pineapple pulp	4.7	2.8

Table 2 Feedstock and Biochar elemental characterization

Parameters	1	2	3	4	5	6	7	8	9	10
pH	NA	11.0	NA	8.0	NA	8.7	NA	8.3	NA	10.3
Total Nitrogen (%)	1.18	1.88	1.04	1.09	1.32	1.70	1.59	1.26	1.08	0.82
Carbon										
C:N										
Phosphorus (%)	0.32	0.73	0.32	0.55	0.32	0.55	0.28	0.73	0.31	0.58
Potassium (%)	3.12	6.59	2.09	3.27	1.20	2.50	0.89	1.39	7.54	11.12
Calcium (%)	1.88	4.36	0.30	0.81	0.23	0.43	0.09	0.07	0.40	0.78
Magnesium (%)	0.26	0.60	0.29	0.46	0.28	0.23	0.22	0.25	0.41	0.44
Fe (%)	0.17	1.10	0.12	0.08	0.19	0.34	0.38	1.64	0.06	0.07
Mn (mg/kg)	45	255	285	280	170	185	165	215	200	255
Zn (mg/kg)	35	375	25	30	220	1055	45	70	70	405
Cu (mg/kg)	Nd	15	10	15	20	35	25	30	20	Nd

NA - Not available

nd - not detected

1. Citrus waste
2. Citrus waste biochar
3. Pineapple peel
4. Pineapple peel biochar
5. Pineapple pulp
6. Pineapple pulp biochar
7. Mango endocarp
8. Mango endocarp biochar
9. Plantain stalk
10. Plantain stalk biochar

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Efficacy of Branded Organic Fertilizer on the Growth and Yield of Pepper (*Capsicum* spp.) Varieties

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Abstract
The use of organic materials in farming has reduced over the year due to the increase in the use of chemical fertilizers which are rich in readily available nutrients. Field experiments were conducted to study the influence of different levels of organic fertilizer application on the growth and yield of Nsukka yellow and bird pepper. The study was conducted at the National Horticultural Research Institute, Ibadan (Lat. 7⁰ 30' N; Long. 3⁰ 50'E) during the 2016 cropping season using branded Aleshinloye- Asejere non- fortified organic fertilizer. The experiment was designed as a 2 x 5 factorial experiment laid out in split plot design with pepper varieties(Nsukka yellow and bird pepper) as the main plot and different organic fertilizer levels of 0,5,10,15,20 t/ha as the sub-plots. Results showed that the vegetative growth parameters and the fruits yield were significantly affected by the variety and the organic fertilizer levels. The organic fertilizer levels improved the plant growth and the yield of pepper. Nsukka yellow variety of pepper has the highest values for all the growth parameters assessed and in most cases significantly higher to the bird pepper. The organic fertilizer levels increased from the control to the highest level. For all the growth parameters and the yield assessed, control has the least values and the values increased as the rate increases up to 20 t/ha.

Keywords: *Organic fertilizer, Nsukka yellow pepper, Bird pepper, varieties, yield*

INTRODUCTION

Peppers are vegetable crops belonging to the family *Solanaceae* and the genus *Capsicum*. They are indigenous to Central and South America. Columbus found them growing in West Indies but were introduced into Europe in the 16th Century (Agricultural Alternative, 2000). Gibbon and Pain (1985) also reported that all *Capsicums* are of American origin, but they are now widely spread throughout the tropical and sub-tropical regions of the world. *Capsicum* consists of approximately twenty two wild species and five domesticated species. The five domesticated species include*C. Annum l., C. baccatum l., C. Chinensis L., C. pubescens l. and C.frutescens L.* (Bosland and Votava, 2000). *Capsicum* can be divided into several groups based on fruit characteristics ranging in pungency, colour, shape, intended use, flavour and size. Commercially cultivated pepper across the world belongs to the species *C. annuum.* (Smith *et al*., 1987). It is one of the most important vegetables grown in Nigeria and other parts of sub humid and semi arid tropics (Aliyu, 2000). *Capsicum annuum* var 'Nsukka yellow' and *Capsicum frutescens* var 'bird pepper' are two important cultivars of pepper that are grown in large quantities in Nigeria under rain-fed conditions. The fruit is a berry; green immature, red, yellow and brown fruits are common.

Soils in Sub-Saharan Africa are inherently infertile and characteristically low in soil organic matter content and cannot support intensive cultivation due to rapid rate of fertility decline under intensive cultivation (Shiyam and Binang, 2013). The use of various fertilizers have addressed these problems (Ojetayo *et al*., 2011; Senjobi *et al*., 2012; Olowoake *et al*., 2013), but the use of inorganic fertilizer to increase the yield has been found to be effective as a short term solution which demands consistent use as a long -term basis. The hazardous environmental consequences and high cost of inorganic fertilizers make them not only undesirable but also uneconomical and out of reach of poor farmers who dominated the Nigerian agricultural sector (Oyedeji *et al.,* 2014).

Aleshinloye-Asejere organic fertilizer is a non-fortified fertilizer produced in Ibadan, South western Nigeria from the various wastes that are being generated in the city.

The demand for vegetables of high nutritive and economic value has contributed to the expanding use of organic fertilizers (Vlahova and Popov, 2013). There is therefore the need to evaluate the growth and yield performance of these pepper varieties using different levels of non-fortified Aleshinloye-Asejere organic fertilizer.

MATERIALS AND METHODS

Field experiments were conducted at National Horticultural Research Institute, Ibadan, Oyo State (7° 30'N, and 3° 54'E; in an altitude of 234m above sea level). The experimental site is located in the rainforest agro-ecological zone.The experiment was a 2 × 5 factorial experiment laid out in a split plot design on 2m x 3m plots and the treatment combinations were replicated three times with both pepper varieties planted at a spacing of 50cm x 50cm.The main plot consists of the varieties (*Nsukka yellow* and *Bird pepper*), while the sub plot was the different organic fertilizer levels (0, 5, 10, 15 and 20t/ha).

The seedlings were raised by sowing the seeds in the nursery trays using sterilized soil for four weeks. The nursery trays were then placed under shade to protect the seedlings from direct influence of raindrops. Watering in the nursery was carried out every other day. Composite soil samples were randomly collected from 0-15cm depth within each plot with soil auger for laboratory analysis. The samples were bulked, air dried at room temperature, crushed and sieved to pass through a 2mm mesh and prepared for soil chemical and physical properties.A sample of the organic fertilizer was also oven dried, blended and analysed for its nutrient contentsaccording to the procedure outlined in Selected Methods for Soil and Plant Analysis Manual of International Institute of Tropical Agriculture, Ibadan (IITA, 1979).The organic fertilizer used was Alesinloye Asejere organic fertilizer; grade B which was incorporatedinto soil by using garden fork two weeks before transplanting the pepper seedlings at different levels of 0, 5, 10, 15 and 20t/ha.Weeding was done manually using the hand or hoe and other appropriate cultural activities were carried out regularly after transplanting. Data collected includes plant height, number of leaves, main branches, number of fruits and the yield.Data were subjected to analysis of variance using linear model procedure of Statistical Analysis software (SAS Inst., 2003)significant means was separated where appropriate using the least significant difference at 5% probability level ($LSD_{0.05}$).

RESULTS AND DISCUSSION

The nutrient composition of the organic fertilizer evaluated in the present study (Table 1) showed that the organic fertilizer contained appreciable amount of plant nutrients which may be adequate to ameliorate the deficiency of the native soil fertility. It has highest content of calcium.

Results of the pre-planting soil analysis showed that the soil was slightly acidic in nature (Table 2). And showed that N, P and K were very low and the textural class of the soil was loamy sand.

The results obtained showed that the effects of variety and organic fertilizer significantly influenced the plant height of pepper with significant variations due to different rates of organic fertilizer application. The rate increased as the rate of organic fertilizer rate increases. There were no significant differences in the interaction between variety and organic fertilizer (Table 3). The significant increase in the plant height could also be due to better availability of soil nutrients in the growing areas, especially nitrogen and phosphorus which have enhancing effect on the vegetative growth of plants by increasing cell division, elongation and varietal variability to absorb nutrient from the soil (Yahaya *et al*., 2010).

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The number of leaves per plant of pepper at various growth periods showed that the effect of variety and different rates of organic fertilizer were highly significant at various growth periods.Both varieties of pepper increased significantly with *Nsukka yellow* variety having more leaves than the bird pepper. As the rate of application increases, there was significant increase in the number of leaves with the highest rate of fertilizer having the highest number of leaves and the control with no fertilizer having the least number of leaves (Table 4).Law-Ogbomo and Remison (2008) reported that uptakes and utilization of applied fertilizer significantly enhanced number of leaves.

Main branches per plant was significantly higher in *Nsukka yellow* variety than the other variety while the rates of organic fertilizer was the least for the control and others significantly increased as the rate of organic fertilizer increased (Table 5). This supports the findings of Law-Ogbomo and Egharevba (2010) who reported that number of branches associated with various soil amendments were significantly different from the control.

The number of fruits per plant and the yield were significantly higher in *Nsukka yellow* variety compared to the *bird pepper* variety (Table 6).The number of fruits and the yield were the least for the control using the different rates of organic fertilizer. The number of fruits and the yield increased significantly as the rate of organic fertilizer increased. Akinfasoye *et al.,* (1997) reported that differential in yields of crops could be attributed to the choice of cultivar grown and its specific genetic makeup.

CONCLUSIONS

Nsukka yellow variety of pepper was better in terms of vegetative and yield assessment while 20t/ha rate of the branded organic fertilizer was the best as it gave promising results.

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Table 1: Nutrient Composition of Aleshinloye Asejere Organic Fertilizer

Nutrient	value
pH	9.8
Nitrogen (%)	1.7
Phosphorus (%)	1.3
Potassium (%)	2.4
Calcium (%)	3.9
Magnesium (%)	0.7
Manganese (mgkg-1)	352
Zinc (mgkg-1)	273
Copper (mgkg-1)	38.2

Table 2: Pre-planting Chemical and Physical Characteristics of the Soil

Soil properties	value
pH	5.7
Total N (g kg-1)	1.3
Available P(mgkg-1)	8.5
Exchangeable K(cmol)	0.1
Exchangeable Ca (cmol)	0.3
Exchangeable Mg (cmol)	0.3
Exchangeable Na (cmol)	0.1
Exchangeable H++ Al	0.2
ECEC (cmol)	0.9
Organic Carbon (%)	17.3
Organic matter	1.03
Sand (g/kg)	825
Silt (g/kg)	122
Clay (g/kg)	53
Textural class	Loamy sand

Table 3: Effect of Variety and Rates of organic fertilizer on the plant height of pepper

		Plant Height			
Treatments	**4**	**6**	**8**	**10**	**12WAT**
Variety					
Nsukka yellow	18.89	31. 07	50. 45	65.89	76.16
Bird Pepper	17.71	26.79	39.61	56.35	67.73
LSD(0.05)	1.59	2.55	4.83	5.55	6.56
Organic fertilizer rates					
0	14.83	21.76	34.56	51. 08	59.33
5	17.17	27.50	41.77	57.20	64.97
10	18.53	29. 41	47.10	62.97	75. 02
15	19.15	31.53	49.75	65.67	76.54
20t/ha	21.85	34. 45	51.95	68.65	83.86
V x OFR	ns	Ns	ns	ns	ns

*Significant at P< 0.05, **Significant at P<0.01, ns- Not Significant. Figures followed by the same letter(s) in each column are not significantly different by Least Significant Difference at 5%. V-variety OFR-Organic fertilizer rates.

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Table 4: Effect of Variety and Rates of organic fertilizer on the Number of leaves of pepper

		Number of	Leaves		
Treatments	4	6	8	10	12WAT
Variety					
Nsukka yellow	19.91	56.31	154.67	224.65	225.8
Bird Pepper	15.98	52.38	151.1	194.9	219. 4
LSD(0.05)	2.96	4.11	17. 05	17.18	14.30
Organic Fertilizer Rates					
0	13.50	38. 04	100. 47	150.72	164.50
5	15.37	47.7	131.55	182.63	219.2
10	16.91	55.5	160.17	220.14	250.7
15	20.15	61.33	174.25	234.2	269.5
20t/ha	23.79	69.16	198. 01	261.17	284.2
LSD(0.05)	4.69	6.50	26.96	27.16	22.61
V x OFR	ns	Ns	ns	ns	ns

*Significant at P< 0.05, **Significant at P<0.01, ns- Not Significant. Figures followed by the same letter(s) in each column are not significantly different by Least Significant Difference at 5%. V-variety OFR-Organic fertilizer rates.

Table 5: Effect of Variety and Rates of organic fertilizer on the Main branches of pepper

		Main	Branches		
Treatments	4	6	8	10	12WAT
Variety					
Nsukka yellow	2. 08	4.88	13.86	14.27	15.68
Bird Pepper	1. 48	3.32	8.21	10.10	15.53
LSD(0.05)	0.76	1. 04	2.76	1.23	3.18
Organic Fertilizer Rates					
0	0.75	2.75	7.79	8.95	9.25
5	1. 08	3.38	8.62	10.63	13. 40
10	1.66	4.01	9.54	12. 43	15.76
15	2. 44	4.39	11.32	13. 48	18.25
20t/ha	2.94	5.9	17. 02	17. 41	21.37
LSD(0.05)	1.20	1.65	4.36	1.94	5. 03
V x OFR	ns	Ns	**	ns	ns

*Significant at P< 0.05, **Significant at P<0.01, ns- Not Significant. Figures followed by the same letter(s) in each column are not significantly different by Least Significant Difference at 5%. V-variety OFR-Organic fertilizer rates.

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Table 6: Effect of Variety and Rates of organic fertilizer on the Number of fruits and Yield of pepper

Treatments	Number of Fruits	Yield(Kg/ha)
Variety		
Nsukka yellow	14.38	1562.89
Bird pepper	8.67	1357.33
LSD(0.05)	3.84	182. 41
Organic Fertilizer Rates		
0	2.12	772. 0
5	10.25	1085.1
10	11.18	1465. 0
15	15.20	1739.1
20t/ha	18.88	2239. 4
LSD(0.05)	10.82	288. 42
V x OFR	Ns	ns

*Significant at P< 0.05, **Significant at P<0.01, ns- Not Significant. Figures followed by the same letter(s) in each column are not significantly different by Least Significant Difference at 5%.V-variety OFR-Organic fertilizer rates

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Evaluation of Different Rates of Poultry Manure on the Growth and Yield of Ginger (*Zingiber officinale)*

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Abstract
Field trial was conducted during the 2017 wet season at the research farm of National Horticultural Research Institute in Bagauda, Kano to determine the effect of different rates of poultry manure on the growth and yield of Ginger (Zingiber Officinale).Six rates of poultry manure (5, 10, 15, 20, 25, and 30 t/ha) and control were investigated. The experiment was laid outin Randomized complete block design (RCBD) replicated three times. Data was collected on plant height, number of leaves per plant, number of shoots, length of rhizome and rhizomes yield.Data collected were subjected to analysis of variance and the means of treatments were separated using Duncan Multiple Range Test (DMRT). Theresult showed that increasing poultry manure above 25t/ha did not provide any significant differences in the plant height, number of leaves per plant. number of shoots, length of rhizome and rhizomes yield. However, maximum values of plant height, number of leaves, number of shoots, length of rhizome and rhizomes yield was recorded in 25 t/ha poultry manure, with corresponding minimum values of plant height, number of leaves, number of shoots, length of rhizome and rhizomes yield observed in the control. Based on the result obtained from this study, it suggested that application of 25 t/ha of poultry manure had beneficial effect on the growth and yield of Ginger.
Key words: Ginger, poultry manure, growth, yield

INTRODUCTION

Ginger (*Zingiber officinale Rosc*) a spice crop is a member of the family *zingiberaceae* and sub-family *zinigeradeae.* It is a monocotyledonous crop which produces rhizomes that serve as the ginger for commerce. The economic part is the underground rhizome, which is pungent and aromatic and used for culinary purposes in ginger bread, biscuits, cakes, puddings, soups and prikles (Modupeola *etal.,* 2012). Ginger enters international markets in three primary forms; fresh (green) ginger, preserved ginger and dried ginger. The dried ginger has more commercial importance compared to preserved or fresh ginger. Aromatic spice is prepared by harvesting and drying the mature rhizome while the fresh ginger, consumed as a vegetable, is harvested when immature or mature. Dried ginger is used directly as a spice and also for the preparation of ginger oil and ginger oleoresin. Organic fertilization is very important to agriculture as the constant use of synthetic fertilizers over the years poses threat to human lives,Optimum growth and yield of plants require nutrients, as deficiency in nutrients results in stunted crop growth and poor yield.

Despite the importance and economic importance of ginger in Nigerian diet, there is scarce information on its cultivation practices that will enhance the growth and its yield.

Organic fertilizers such as poultry manure can be used to complement inorganic fertilizers in order to circumvent the risk attributed to sole use of inorganic fertilizer for crop production. Thus increasing nutrient availability and enhancing soil

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properties for sustainable crop production (Babatola *et al* 2012).

Moreover, due to high cost and scarcity, most farmers cannot afford the use of these chemical fertilizers which necessitates research into organic wastes that are cheap, readily available and environmentally friendly and can be used as fertilizers (Ayeni *et al*, 2010). Chicken manure has long been recognized as perhaps the most desirable of these natural fertilizers because of its high nitrogen content (Ghanbarian *et al,* 2008). Furthermore, studies carried out in Nigeria and elsewhere confirmed poultry manure as effective nutrient sources for increasing nutrient status of the soil and yield of crops such as maize, amaranthus, sorghum and pepper (Adeniyan and Ojeniyi 2005; Akanni and Ojeniyi, 2005). The objective of this study therefore is to determine the optimum level of poultry manure that will give best rhizomes of ginger.

MATERIALS AND METHODS

A field experiment was carried out during the period of May to October 2018 at the research farm of the National Horticultural Research Institute, Bagauda, Kano locatedon Latitude $11^0 33^N$ and Longitude $8^0\ 23^{\text{‘}E}$ at an altitude of 481m above sea level. The experiment was laid out using a Randomized Complete Block Design (RCBD). The treatment consisted of six (6) dosage of poultry manure and control (0t/ha, 5t/ha, 10t/ha,15t/ha,20t/ha,25t/ha and 30t/ha). The gross, plot size was 2m x 1.5 = 3m^2

Ginger rhizomes were cut into sett and planted at the depth of 5cm at 30cm x 50cm spacing. The recommended cultural practices were applied uniformly for all treatments according to KAU (1996).

Harvesting of the crop was done when the leaves began to change colour from green to yellow, thereafter the rhizome were separated from the ginger plant. The poultry manure used was analyzed for chemical properties. The manure was applied after the land preparation two weeks before planting and the second application was at eight (8) weeks according to the dosages, Data was collected on plant height, number of leaves per plant. Number of shoots, length of rhizome and rhizomes yield. Data collected were subjected to analysis of variance and the means of treatments were separated using Duncan Multiple Range Test (DMRT) (Duncan, 1995)

RESULT AND DISCUSSION

The pre-planting soil analysis (Table 1) showed that the textural class of the soil in the experimental plot is sandy loam, slightly acidic .(6.27), low in total nitrogen (1.08), exchangeable magnesium(2.40) and available phosphorous (1.55). The chemical analysis of the poultry manure (Table 2) shows that it was high in organic matter (700 ppm) and had more nitrogen (1.62 Kg^{-1}) and calcium (2653 ppm) than potassium (0.187%) and magnesium (4217ppm).

From the result on Table 3,4 and 5, the effect of poultry manure can clearly be seen as it affects the morphological, yield and yield contributing characters of the ginger plant. The plant height, number of leaves, number of shoot, length of rhizome and total yield (t/ha^{-1}) differed significantly. The plant height was more improved and different from treatment with 25t/ha of poultry manure giving 63.7cm, the least value was recorded in the control (O t/ha) with about 38.2cm, further increase of the poultry manure to 30 t/ha does not give any significant difference to the plant height.

Table 4 shows the number of leaves of the ginger plant, the O t/ha treatment produced the least (12.4) number of leaves while the highest number of leaves was produced by treatment with 25 t/ha (16.8) increasing the dosage to 30 t/ha (14.3) does not increase the number of leaves.

Table 5 shows the number of shoots, length of rhizome and yield (t/ha) of the

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ginger plant, the highest number of shoots and length of rhizome was found in the treatment with 25 t/ha dose which clearly showed a mark difference compare to the other treatments

Further increase to 30 t/ha does not affect the number of shoots/ length of rhizome, this clearly shows that increasing the dosage does not further affect the number of shoots/ length of rhizome.

The significant increase in yield under 25 (t/ha) dose shows that the maximum requirement of the plant for organic manure has been attained as this agrees with the findings of Olasantan (1994) which reported that maximum benefits are derived from adequate application of fertilizer to vegetables grown with higher levels of organic manure performed better and resulted in a final higher total yield than those grown with lower amounts or those grown using synthetic fertilizers alone.

Generally, application of poultry manure at the rate of 25 t/ha increase growth and yield of ginger as indicated by the plant height, number of leaves, number of shoot, length of rhizome and yield of rhizome. Discussing all these results with only one reference is not enough. There are several literatures on this topic on ginger production. Check and improve on this.

CONCLUSION

It is evident from the result of this study that ginger benefited from the plant nutrients supplied in the poultry manure helped to enhance the soil physical and chemical properties for increased production. Application of 25 (t/ha^{-1}) of poultry manure had the best performance in terms of growth and yield of ginger. Considering the risk associated with the conditions, use of inorganic fertilizers, organic fertilizers such as poultry manure which contains essential nutrients and helps in enhancing the soil should be used to compliment inorganic fertilizer. Different organic manure can also be composed before use to make handling easier. Moreover, organic manures are relatively cheaper and more accessible and will reduce cost of production. Therefore, from the result obtained in this study, the use of 25 t/ha of poultry manure is recommended for ginger production.

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Table 1: Pre-cropping physical and chemical characteristics of soil

Soil properties	0-15cm	15cm – 30cm
Particle size distribution (%)		
Clay	10	23
Sand	54	42
Silt	30	31
Textural class	sandy loam	sandy loam
Chemical Properties		
pH in water	6.0	6.27
pH in 0.01m $CaCl_2$ 5	9	4.24
Organic carbon (g/kg^{-1})	6.00	4.47
Total Nitrogen (g/kg^{-1})	1.30	1.08
Available phosphorous (Meg/kg^{-1})	6.04	1.55
Exchange bases ($Cmol/Kg^{-1}$)		
Ca	0.32	0.98
Mg	1.16	2.40
K	0.16	0.18
Na	0.17	0.23
CEC	8.35	10.21

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Table 2: Proximate analysis of poultry manure

Properties		value
PH (H_2O)	-	8.2
OM (gkg)	-	700
Total Nitrogen (g/kg^{-1})	-	1.62
Available phosphorous (Meg/kg^{-1})	-	0.201
Potassium %	-	0.187
Calcium (ppm)	-	2653
Magnesium (ppm)	-	4217
Zinc (ppm)	-	253
Copper (ppm)	-	9.32

Table 3. The mean plant height of ginger plant as affected by poultry manure

	Weeks after planting					
Treatment (t/ha)	5	7	9	11	13	15
5	14.2d	17.3c	18.1e	18.3f	23.4f	38.2e
10	16.3c	18.9b	19.7d	22.8d	25.6e	52.6d
15	16.9c	19.2b	20.1c	21.7e	27.8d	54.3
20	18.9b	20.4b	22.6b	22.6c	29.7b	59.2b
25	19.6a	22.9a	25.8a	27.9a	32.6a	63.7a
30	18.1b	20.2b	22.6b	24.3b	29.6c	57.3c
SE	1.03	2.01	0.87	0.72	0.63	0.18

Table 4: Effect of poultry manure on the number of leaves.

	Weeks after planting					
Treatment (t/ha)	5	7	9	11	13	15
0	4.2d	5.2d	6.3d	9.8c	11.3c	12.4e
5	5.0c	6.0c	7.3c	10.4c	11.2c	12.7e
10	5.2c	6.1c	7.1c	10.9c	12.6b	14.1c
15	5.4c	6.8b	7.3c	11.1b	12.8b	13.7d
20	6.1b	6.6b	9.1b	11.1b	12.2b	14.8b
25	7.8a	8.6a	10.1a	13.1a	14.2a	16.8a
30	7.2a	7.8a	8.9b	11.7b	13.2b	14.3b
SE	0.11	0.12	0.18	0.14	0.18	0.16

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Table 5. The mean number of shoot, length of rhizome and total yield of rhizome as affected by poultry manure.

Treatment (t/ha)	No of shoot	Length of rhizome	yield of rhizome (t/ha)
0	8.3d	18.6	13.0f
5	8.7d	18.7f	14.0e
10	8.6d	19.6e	18.1d
15	9.1c	21.3d	18.6d
20	9.8b	20.1c	20.1b
25	10.3a	27.2a	22.6a
30	9.8b	25.5b	19.1c
SE	0.06	0.52	0.49

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Effects of Bio Fertilizers on the Nutrients and Minerals Composition on Amaranthus *Caudatus* spp. Grown in Pot Experimental Designed.

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***Abstract**:*
The application of bio-fertilizer is considered as good agricultural practice because it improves the fertility of the soil and plant quality. There are various ways of application mode for bio-fertilizer namely: Soil, Foliar, and seed application. In this study, these three application mode with control was used to study the effects on the biochemical parameter and minerals content in the amaranthuscaudatus spp. This evaluation was carried out in a pot set out on the field during the raining season of 2018.Result generally revealed that application of liquid formulation of biofertilizer showed significantly @ p<0.05 improved crop and better biochemical properties over uninoculated control.It shows that there is significant change and increase @ p<0.05 in the total chlorophyll (2.80 mg/g), total carotenoid (3045 µg/100g), pro- vitamin A (507.5 ui/100g) and total polyphenol (10.67 mg/g) for the application of foliar spray.For the mineral nutrients, the soil application shows some level of increases over others applications and control. This finding show the best way to achieve its maximum efficacy for the micronutrients is through soil application, since carrier-based microbes find their ultimate habitat in soil.
Keywords: *Biofertilizer, soil, foliar, seed and nutrient qualities.*

INTRODUCTION

Biofertilizer was defined as “a product that contains living microorganisms, which exert direct or indirect beneficial effects on plant growth and crop yield through different mechanisms”. The definition was extended as the bacteria were used to control plant pathogens (Sahu *et al.,* 2014). Biofertilizers have an ability to mobilize nutritionally important elements from non-usable to usable form. These microorganisms require organic matter for their growth and activity in soil and provide valuable nutrients to the plant. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Through the use of biofertilizers, healthy plants can be grown while enhancing the sustainability and the health of soil (Revathi *et al.*, 2012).

Liquid biofertilizer technology is an alternative solution to carrier based biofertilizers. It comprises aids to preserving organism, to delivering them to their targets and improvestheir activities. These are special liquid formulation containing not only the desired microorganism and their nutrients but also special cell protectants or substances that encourage formation of resting spores or cyst for longer shelf life and tolerance to adverse condition. Unlike the lignite based biofertilizers, liquid biofertilizers have a longer shelf life (Faheed and Fattah, 2008). By applying an appropriate liquid biofertilizer, the overall cost of production will be much lower as compared to traditional chemical fertilizers (Hellal *et al.*, 2011).

Biofertilizer is a substance which contains living microorganism and when applied to seeds, plant surfacesor soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Chemical fertilizers directly increase soil fertility by adding nutrients. However biofertilizer add nutrients through the natural processes of fixing atmospheric nitrogen, solubilizing phosphorus, and stimulating plant growth through the synthesis of growth promoting substances.

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Biofertilizers contain living microorganisms that colonize the rhizosphere or the interior of the plants and promote growth by increasing the supply or availability of primary nutrients to the target crops, when applied to soils, seeds or plant surfaces". The main objectives of the work is to study the effect of the modes of application of biofertilizers on the nutrients composition on amaranths.

MATERIALS AND METHODS

Pot experiment was conducted to study the effect of biofertilizers, when applied to soils, seeds and foliar spraying, and some physiological parameters (soluble sugar %, protein %, and nutrient contents (Na, P, K, Mg, Mn, Zn and Cu) (AOAC, 1999), Ascorbic acid (Roe and Keuther, 1953), carotenoids µg g ^{1} and total chlorophyll (Zakaria*et al*., 1979), ProVitamin A (Bayfield and Cole, 1980) and total phenolic mg/g (Lowry *et al*., 1951) of plants were examined with the plants (control).

This evaluation was carried out in a pot set out on the field during the raining season of 2018. The test crop used was Amaranth*caudatusspp*.. The experiment was established using a 7 liter bucket filled with 8 kg of soil. The treatment included Biofert 3 in 1 (Soil applied, foliar applied and seed/seedling treatment) and control. The experiment was replicated three times. Regular watering and weeding was carried out as at when necessary.

The treatments are as follows:

Biofert soil: This was applied by mixing 4mls of biofert with 1 kg of organic manure and applied 2 weeks before planting.

Biofert foliar: This was applied by adding 4mls of biofert to 1 liter of water with 1g of dextrose, the mixture was left for 6 hours before application.

Biofert seed: This was applied by adding 10mls of biofert to 1 liter of water, seeds or seedlings of the plants were soaked in the solution for 1 hour before planting or transplanting.

Control: No application of any fertilizer.

The experimental design was Completely Randomized Design (CRD). The data collected were subjected to statistical analysis using SAS software, analysis of variance was done and significant means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

DISCUSSION

For the biochemical analysis, the highest values of all the mentioned parameters were obtained by using foliar application, followed by the soil application. Foliar spraying treatments significantly increased the physiological parameters as well as nutrients content of amaranth plants as compared with control. For the soluble sugar, foliar application have the highest obtained value with 1.6 % followed by the soil method of application (1.4 %). Also for protein, the foliar spray applied shown a figure of 1.1 % has the highest followed bysoil application value 0.8 %. For carotenoids and total polyphenol the foliar spray application have the highest values with 3045 µg/g and 10.67 mg/g respectively. Applying foliar nutrients to plants is to enhance essential nutrients and biochemical content in a readily available form. Biochemical analy**sis** revealed that, foliar spray of botanicals increased total carotenoids, total soluble sugar, total soluble protein and total soluble phenolic content.

For the minerals analysis contents, nutrient contents (N, Na, P, K, Ca, Mg, Mn, Zn and Cu) of amaranth plants were significantly increased by biofertilizers with different application techniques as compared with non-biofertilizer plants (control). The highest values of all the mentioned parameters were obtained by using soil application followed by foliar spray application except in P which is higher in the seed application. These finding are in

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agreement with those reported by - Revathi*et al.*, 2012 and Sahu*et al.*, 2014. Micronutrients in amaranth plants differed as the foliar treatments were differed, so application of any micronutrient individually significantly increased its content and enhanced the content of other micronutrients in wheat (Stella and Sivasakthivelan, 2009). Interaction between the used biofertilizers and foliar spraying with micronutrients significantly affected all the studied parameters of amaranth plants, the highest were obtained by soil application, while the lowest values were attained by non-boifertilizer (control). Roots are the digestive system of plants. The more root surface there is, the more nutrients the plant can take up. This translates to more yield potential. Roots are all about surface area. Micronutrients are an important nutrient, and are very mobile in soils (Akaparobi, 2009; Olaniyi*et al.*, 2008).

CONCLUSION:

The Bio-fertilizer application through soil has shown to significantly increase the root to soil contact (more roots, more fine root hairs), which in turn, increases the uptake of minerals. This finding are in conformity with others which show the best way to achieve its maximum efficacy for the micronutrients is through soil application, since carrier-based microbes find their ultimate habitat.

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Results

Table 1: Biochemical parameters of biofertilizers applications and control

Application mode	Total chlorophyll	Total carotene	Total protein	Vit A	Vit C	Total soluble sugar	Total polyphenol
Unit	mg/g	µg/100g	g/100g	Ui/100g	mg/100g	g/100g	mg/g
Soil	$2.18^{b} \pm 0.03$	$2641^{b} \pm 18.5$	$1.8^{a} \pm 0.04$	440.17b ± 4.35	13.85a ± 1.08	1.64a ± 0.04	8.34b ± 1.05
Seed	$2.12^{b} \pm 0.03$	$2409^{bc} \pm 17.1$	$1.75^{a} \pm 0.03$	401.5c ± 4.8	13.66a ± 1.09	1.63a ± 0.05	7.65c ± 0.98
Foliar	$2.80^{a} \pm 0.05$	$3045^{a} \pm 26.1$	$1.81^{a} \pm 0.03$	507.5a ± 5.1	13.49a ± 1.08	1.65a ± 0.05	10.67a ± 1.15
Control	$1.81^{c} \pm 0.04$	$2066^{c} \pm 17.9$	$1.62^{d} \pm 0.04$	344.33d ± 4.65	12.08b ± 1.01	1.25b ± 0.04	6.84d ± 0.85

Values with the different subscript along the column are significantly different at $p<0.05$.

Table 11: Minerals composition of biofertilizers application

Parameters	N	P	Na	K	Mg	Ca	Mn	Zn	Cu
Unit	%	mg/100g							
Soil	0.65±0.0	55.8±0.9	164.4±1.8	3841±2.9	2450±3.4	330±3.6	8.2±0.2	12.5±0.5	30.5±0.9
Seed	0.63±0.0	54.8±0.8	120±2.3	3311±5.4	1881±4.1	277±3.1	5.6±0.1	8.5±0.3	27.5±0.7
Foliar	0.71±0.0	45.3±0.5	128±2.0	3246±4.4	1980±4.8	295±4.7	6.5±0.2	10±0.4	28.6±0.6
Control	0.61±0.0	36.5±0.4	108±2.1	3120±4.9	1840±5.1	258±3.9	6.2±0.1	8±0.2	25.4±0.7

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Effect of Wastewater Used for Irrigation on Profile Distribution of Nutrients Along River Salanta.

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Abstract
The study was carried out along the bank of River Salanta (Sharada) in Kano State, Nigeria. Three profile pits were excavated and four soil samples were collected based on profile depth of 30 cm intervals. Soil pH (>7) were slightly alkaline and non-saline, heavy metals (Cr, Ni and Pb) were within EU standard and Cd slightly exceeding. Soil micronutrients (Cu, Mn and Zn) were above their permissible limits with Fe within range. Waste water samples were collected through grab/catch method adjacent from each profile pit at the respective sampling locations, and analyzed for cations, anions, micronutrients and heavy metals. Irrigation water indicates that pH were slightly alkaline (7.25-7.28), EC mean values were non saline (1.98-2.13dSm^{-1}), the concentrations of Na ranged as (5.33-6.90 cmol/l). The values of Cu and Mn were higher than the FAO limits while Fe and Zn were within range. Chromium, Ni and Pb were within the FAO permissible limits while Cd has been exceeded. Water parameters correlated significantly with soil chemical properties at some profile depths.
Keywords: wastewater; profile depth; urban agriculture; River Salanta.

INTRODUCTION

Urban agriculture has offered some range of benefits and remains marginal in the urban planning process but has been strongly opposed by government agencies. This is due to a variety of negative health, environmental, economic and cultural hazards (Binns and Lynch, 1998). Some proponents believed that urban agriculture is damaging the environmentwhile others suggest that it could be the solution to a number of other important environmental problems (Binns and Lynch, 1998). The use of wastewater as an alternative for fresh water has equally spread to areas downstream of urban centers (Scott *et al.,* 2004). It has been estimated that over 20 million hectares of land has been under irrigation with waste water in over 50 countries (Hussein *et al.,* 2001).

MATERIALS AND METHODS

The Study Area

River Salantais a slow flowing river that flows through the Sharada and Challawa industrial areas of Kano city and located betweenlatitude 11° 63' N to N11° 67' N and longitude 8° 43' E to 8° 56' E. The river has an average speed of about 4.5km/h, with a mean depth of2meters and a width of about 6.5meters.

The soils were classified as Alfisols (Mukhtar and Samndi, 2017) and the major land use iscultivation of vegetables (Binns, *et al.,* 2003).

Field Work

Field study was carried out along the bank of River Salanta. The study site has an area of 27 hectares and perimeter of 3.9 kilometers. Three profile pits were sunk and four soil samples were collected from each soil pit based on profile depth of 30 cm intervals. Irrigation water were also sampled through grab/catch sampling method(AWWA, 1999)from the river in a rinsed labeled plastic containersfor chemical analysis.

Laboratory Analysis

Soil samples were air-dried, ground and sieved (<2 mm) for laboratory analyses.The pH was determined in water (1:2),Ca^{2+} and Mg^{2+} in solution were read on an AAS,K^+ and Na^+ were read on the flame photometer while CEC was determined by the NH_4OAc saturation method. Organic carbonwas determined by wet oxidation method, TN byMicro-

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Kjeldahl method and micronutrients were determined through 0.1M HCl.

The pH and EC of water were determined using pH (Jenway Model 3520) and ECmeter (Jenway Model 4520) in the laboratory. Heavy metalsand micronutrients (Cu, Pb, Zn, Fe, Mn, Cd, Ni, and Cr) were extracted with HNO_3 as described by Backstrom *et al,* (2003). The samples were analyzed for Na^+ and K^+ using Flame photometer while Ca and Mg were determined using AAS.

RESULTS AND DISCUSSIONS

Distributionof elements by depth across site are presented on Table 1.Nitrogen slightly decreased with increase in profile depth andrated low (Esu, 1991). This is probably as a result of the origin of wastewater which is industrial rather than domestic.However, Npredominated the surface horizons probably from addition of organic waste during farming.

Sulphur was rated highwhich might be ascribed to the nature of wastewaterfrom tanning industries that contain some amounts of S from Cr salts of SO_4.. Sulphur decreased with increase in profile depth, which might be attributed to additions of OM, fertilizers and agrochemicals at the soil surface. .

Phosphorus vary slightly between the depths with high values at surface soils and decreased down the profiles which might be ascribed to additions from irrigation water andsome anthropogenic influences such as applicationof fertilizers containing phosphorus and mineralization of organic residue at the surface soils.

The concentrations of calcium were rated medium (Esu, 1991). Calcium values for soils under irrigation with slightly alkaline pH have fairly moderate to high values (Adamu, 2013). Calcium tends to slightly increase down the profile. The sandy textured nature of the soil and frequent irrigation might be responsible for the slight increase of Ca down the profile as reported by Adamu (2013).The decrease in Na down the profile may be due to long-term accumulations of sodium salts from continuous irrigation and high surface evapotranspiration. The levels of sodium in all the three sites were rated high.The mean values of magnesium were rated medium (Esu, 1991). The observed trend of distribution in the profiles was similar to that of calcium except that magnesium was less concentrated than calcium in all the soils.

The distributions of extractable micronutrients by depth across sites are presented inTable 2. Iron (Fe) content across the profile depth of each pit vary slightly and rated high (Esu, 1991), implying that Fe deficiency is very unlikely for any crop grown on these soils.Manganesein the profile pits varied significantly across the profile depth with valuesthat suggest the soil contain sufficient Mn for successful agriculture in the study sites as they were above the critical limits of 3-5mgkg^{-1} as reported by by Esu (1991). Based on profile depth distribution, Zn ranged from 5.75-4.78 mgkg^{-1} with the values of the surface horizonbeing higher. Accumulation of Zn takes place in the surface soil because organic matter and humus tends to sorp with Zn at the surface soils and limits its mobility down the profile (Kabata and Pendias, 1999). The higher accumulation of Zn in this study area is essentially due to anthropogenic influence which includes extensive use of fertilizers, cow dung, and tannery sludge as soil amendment materials. Distribution of Cu with depth did not vary much however, there was a slight decrease in Cu mean values with depth (2.29-1.89 mgkg^{-1}). This indicates that while the surface soil contain sufficient amount of Cu for crop production, the subsoil may still serve as a reservoir for replenishing lost Cu taken up by plant roots and/or lost through other means. Cu is a metal that is mostly adsorbed at the top soil by clay and/or

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organic matter and for most of the metals, this adsorption increases with increasing pH (Wild, 1996).

Cadmium distribution across the three pits decreased with increasing profile depth.The profile distributions of Cd was in agreements with the findings of Abdelgawad, (2003) but lower than Awode *et al* (2008).Chromium were rated slightly highprobably due to presence of tanning industries (Maldanado *et al.* 2008). The distributions of chromium down the profile did not vary much although Chromium values were higher (2.46 $mgkg^{-1}$) at the surface soils (0 - 30cm) than subsurface (1.89 $mgkg^{-1}$) (90 – 120 cm)probably due to alkaline nature of the soil pH<7 (Akan *et al.,* 2010).The concentrations of lead in the study site were however, appreciably within range because traffic exhaust was still present and the only source of the metal as many irrigators were found to be using powered pumps for irrigation. Mobility of lead down the profile wasinsignificant and a tendency of Pb level to decrease with depth was observed.Affinity of metals to organic matter could be responsible for this surface enrichment because of the relatively high organic carbon concentration in the top soil (Agbenin, 2002).

The wastewaterpH values (7.22-7.28) and EC (0.48-2.13dSm^{-1}) are within safe limit (FA0, 1992). Na ion concentration obtained at the three locations ranged from 5.33-6.90 cmol/l and interpreted as safe based on FAO (1992). Excess Na in irrigation water affect soil structure and permeability (Mace and Amrhein, 2001).

Magnesium values were 1.80, 1.13 and 1.67 cmol/lat profile (1, 2 and 3)respectively andwere within safe limit (FAO, 1992). The relatively lower amounts ofMg compared to the Ca may be good because Mg deteriorates soil structure particularly where waters are sodium dominated. The values of potassium across the respective study locations were 16.40, 28.27 and 18.40 cmol/l at profile (1, 2 and 3) respectively.The presence of potassium ions in excessive amounts does not constitute any risk and may even supplement crops' needs as only values exceeding 50cmol/l may be considered as posing any serious risk factor with irrigation water.

The concentrations of Pb across the three locations were 0.27, 0.20 and 0.20mgl^{-1} across the three profiles (1, 2, and 3)and within safe limit.Industrial effluents are the main cause of the high levels of lead in the water (Mohsen, 2008). The mean concentrations of Cd across the three sites were 0.40, 0.43 and 0.53mgl^{-1}.The mean concentrations of Cr across the three sites were 0.28, 0.25 and 0.17mgl^{-1}indicate locationsrespectively. The higher values of Cr in the three locations may be attributed to the facts that Cr is an element that is associated with industrial waste waters especially the tanning industries (Maldonado*et al*., 2008). The standard for irrigation water approved by FAO (1992) for Cr is 0.1mgl^{-1} for neutral to alkaline soil, meaning the water is not safe for irrigation with respect to Cr content.

Micronutrients status ofirrigation water is presented in Table 6. The results showed that Cu content in all the three sites were found not to be within the safe limit of (0.2mgl^{-1}) as reported by (FAO, 1992). The higher Cu values in industrial wastewater have also been highlighted by Binns *et al.* (2003) and Mohsen (2008). The mean values of Zn across the three study sites were 0.67, 1.08 and 0.75mgl^{-1}respectively and they are all within safe limit for irrigation (FAO, 1992). These results showed that Zn content of all the three sites were found in deficient concentrations below the standards. Likewise the values of Fe and Mn were all within FAO recommended threshold.

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Correlation between nutrients in water andnutrients in soil.

Table 7 and 8 showed the relationship between metal in irrigation water and concentration detected in soil at 0-30 and 30-60cm while Table 9 and 10 showed the relationship between concentration of metals in irrigation water and concentration detected in soil at 60-90 and 90-120cm, respectively.

Significant correlations were found among some of the soil and water parameters at different profile depth. Some of the cations in water correlated positively and significantly with the cations in soil and the relationship between some anions in water and in soil were also positive and significant. This implies that the wastewater used for irrigation is responsible for some of the soil properties and an increase in its application leads to an increase in the concentration of the metals in the soil.

Across all the depth (0 - 30, 30-60, 60-90 and 90 - 120cm) a negative significant correlation was observed between pH in water and P in soil. One of the major influencing factors for P availability is soil pH (Seshadri *et al.* 2013) where P decreases with increase in soil pH across all the sites.

As observed in Table 7, 8, 9 and 10, irrigation water tended to significantly increase the content of Ca, Na, N, P, K and S in the soil at different depth (0-30, 30-60, 60-90 and 90-120cm). The significant relationship between Ca in water and in soil at 90 -120 might be the sandy textured nature of the soil and frequent irrigation which accumulated down the profile. Similar results were reported by Mancino and Pepper (1992). Abedi-Koupai *et al.*, (2006) found that the total Nand available P concentrations increased significantly in sewage water irrigation treatment and also by Khaskhoussy *et al.*, (2013) who investigated the effect of treated sewage water on soil, in which the soil treated with wastewater had significantly ($P<0.05$) higher contents of Na, Cl, Ca, Mg, N, P and K. This observation was confirmed by Angin *et al.*, (2005) who reported that irrigation using raw sewage water increased soil organic matter, nitrogen and concentrations of major cations.

Correlation between heavy metals in water and heavy metals in soil.

Table 7, 8, 9 and 10 showed the relationship between heavy metal concentrations in irrigation water and the total concentration detected in soil. At 0 - 30cm Ni, Cr and Cd in water significantly correlated positively. These can give a better explanation to this relationship.withthat in the soils; implying the amount of the metals in water contributes to the soils during irrigation. At 30 – 60cm, Pb, Cr and Cd in water correlated significantly with soils; while Cu correlated insignificantly. Similar observations were made by Maldanado *et al.,* (2008), they found significant correlation for Pb, Cd, Cr, Ni and Cu in all sites and areas with previous and current histories of wastewater use for irrigation.

The relationship between concentration of metals in irrigation water and concentration detected in soil at 60 – 90 and 90 – 120cm were insignificant, respectively. Statistically the distribution of metals at 60 – 90cm and 90 – 120cm varied insignificantlyand the probable explanation might be ascribed to the alkaline nature of the soil pH (>7) and organic matter. It is well known that soil pH plays an important role in the mobility of nutrient elements in soil (Sparling and Lowe, 1998). Also organic matter levels in soil plays important roles in sorption and desorption processes of soil (Gray *et al.,* 1999). Thelow levels of soil organic matter at 60 – 90 and 90 – 120 cm therefore influenced the relationship between soil and water contents of the metals than at 0 – 30cm and 30 – 60 cm where the organic matter content is high.

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CONCLUSION

Fromthe findings,it can be deduced that wastewater affected soil properties across the three sampled points as shown by the level of correlation of metals found in the wastewater and that present in the soil at different depths.Also results obtained showed that the use of wastewater slight affected the fertility status of the soils due to slightly higher levels of N, P, K, OC, CEC and micronutrients and also resulted in elevated levels of sodium accumulation and toxic metals in the soils to chronic level in some situations thus, might affect the productive capacity of the soil.

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Table 1: Distribution of Nutrient elements by depth.

Treatment	N gkg^{-1}	S $mgkg^{-1}$	P $mgkg^{-1}$	Ca --------	Mg ---------	K $cmolkg^{-1}$	Na ------
Depth(D)							
0-30	0.11	4.14	15.26	2.99	0.83	0.53	1.35
30-60	0.05	3.26	12.90	2.57	0.87	0.44	0.92
60-90	0.06	3.79	11.90	2.18	0.82	0.40	0.61
90-120	0.08	3.35	11.86	2.70	0.85	0.31	0.72

Table 2: Distribution of Extractable Micronutrients by depth.

Treatments	Cu --------------	Fe $mgkg^{-1}$---	Mn ------------	Zn ------------------
Depth cm (D)				
0-30	2.29	16.41	20.00	5.75
30-60	2.25	15.04	19.11	5.49
60-90	2.15	16.41	24.00	4.83
90-120	1.89	16.41	24.44	4.57
Esu, 1991	0.2-1.0	2.5	1-5	1-2

Table 3: Distribution of heavy metals by depth.

Treatments	Cr --------------	Cd ----$mgkg^{-1}$	Ni -------------	Pb -----------
Depth cm (D)				
0-30	2.46	5.33	5.89	0.42
30-60	2.07	4.67	5.67	0.34
60-90	1.99	4.56	4.96	0.38
90-120	1.89	4.00	4.95	0.34
EU Standard	100	3.0	75	300

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Table 4. Chemical properties of irrigation water.

Treatment	pH	EC dSm^{-1}	Ca ----	Mg -------	K cmol/l---	Na ----	SAR
Sites							
Site 1	7.25	2.02	4.73	1.80	16.40	5.33	0.04
Site 2	7.28	2.13	6.73	1.13	28.27	5.91	0.09
Site 3	7.22	1.98	4.00	1.67	18.40	6.90	0.22
FAO 1992	6.5-8.4	3.0	20	5	2.00	9	13

LSD= least significant difference, * = significant at 0.05, ** = significant at 0.01. FAO = Food and agricultural org.

Table 5: Micronutrient status in irrigation water.

Treatments	Zn ---------	Cu mgl^{-1}---------	Fe ----------------	Mn ---------
Sites(S)				
Point 1	0.67	0.39	0.78	0.67
Point 2	1.08	0.39	0.28	0.73
Point 3	0.75	0.52	0.22	0.87
FAO(1992)	2.0	0.2	5.0	0.2

LSD= Least Significant Difference, * = significant at 0.05, ** = significant at 0.01, FAO= Food and Agricultural Oraganization.

Table 6: Heavy metal status in irrigation water.

Treatments	Cr ---------	Ni -mgl^{-1}------------	Pb ---------	Cd ---------
Sites(S)				
Point 1	0.28	0.18	0.20	0.40
Point 2	0.25	0.18	0.26	0.43
Point 3	0.17	0.13	0.26	0.53
FAO(1992)	0.1	0.2	5.0	0.01

LSD= Least Significant Difference, * = significant at 0.

Table 7: Correlation between water and soil chemical parameters (0-30cm)

Soil properties	Water					
	pH	EC	Ca	Mg	K	Na
P	-0.49*	0.12	-046	0.30	-0.37	-0.27
Ca	-0.30	-0.02	0.05*	0.34*	0.48	-0.04
Mg	0.14	-0.58	-0.63	0.31*	-0.41	-0.05
Na	0.23*	0.22	0.49	-0.43	0.33	0.89*
K	0.30*	0.63	0.35	-0.62	0.61*	0.70*
S	0.24	-0.57	0.03	-0.01	0.01	0.19
N	-0.24	-0.38	-0.04	0.42*	-0.32	-0.02

** = P ≤ 0.01, * = p ≤ 0.05

Table 8: Correlation between water and soil properties (30-60cm)

Soil properties	Water						
	pH	EC	Ca	Mg	K	Na	NO_3
P	-0.27*	0.20	-0.57	0.78*	-0.64	-0.73*	0.68
Ca	-0.91	0.47	0.07*	0.16	0.08	-0.36	-0.79
Mg	-0.23	-0.75	0.16	0.35*	-0.34	-0.43	0.34
Na	0.11	0.25	-0.57	-0.71*	0.75*	0.49*	0.41**
K	0.27	0.64	0.42	-0.24	0.42*	0.05	0.52
S	0.25	0.12	-0.32	0.39	-0.32	-0.75	-0.44
N	0.17	-0.39	0.37	-0.25	0.37	0.01	0.61*

** = P ≤ 0.01, * = p ≤ 0.05

Table 9: Correlation between water and soil properties (60-90cm).

Soil properties	Water					
	pH	EC	Mg	Ca	K	Na
P	-0.60*	0.01	0.79**	-0.66*	-0.74*	-0.74
Ca	0.08	0.01	0.35	-0.55	-0.41	-0.40
Mg	0.72	-0.09	0.27*	-0.06	-0.36	-0.22
Na	0.17	0.89	-0.82**	0.55	0.83**	0.47
K	-0.07	0.73*	-0.11	0.57	0.27	0.16
S	0.28	-0.41	0.05	-0.26	-0.15	-0.10
N	-0.08	0.28	0.27	0.08	-0.15	-0.42

** = P ≤ 0.01, * = p ≤ 0.05

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Table 10: Correlation between water and soil properties (90-120cm).

Soil properties	Water						
	pH	EC	Ca	Mg	K	Na	NO_3
P	-0.39*	0.10*	-0.52	0.88**	-0.70*	-0.70*	0.70
Ca	0.79**	-0.32	0.37*	-0.03	-0.16	0.53	0.80*
Mg	-0.08	0.37*	0.13	-0.10	-0.18	0.25	-0.31
Na	0.32*	0.03*	0.55	-0.73*	0.67*	0.55	0.71
K	0.54*	0.58	0.61	-0.31	0.16	0.45	0.69
S	0.28	-0.57	0.20	-0.58	-0.35	0.07	0.24
N	0.38	-0.04	0.06	0.27	-0.40	-0.06	0.30

** = $P \leq 0.01$, * = $p \leq 0.05$

Table 11: Correlation between metals in soil and metals in water (0 – 30cm).

	Pb in H_20	Ni in H_20	Cu in H_20	Zn in H_20	Cr in H_2O	Cd in H_2O	Fe in H_2O	Mn in H_2O
Soil Pb	0.60*	0.27	0.78*	-0.66*	0.67	0.39	-0.11	0.15
Soil Ni	0.51	0.53*	0.11	0.72	0.17	0.44	0.25	0.38
Soil Cu	-0.75	0.47	0.44	0.38	-0.47	0.39	-0.26	0.78
Soil Zn	0.12	-0.47	0.52	-0.56	0.26*	0.56	0.21	0.65
Soil Cr	0.29	0.99	-0.83*	0.44	0.74*	0.77	0.19	0.87
Soil Cd	0.62	0.18	0.39	0.77	0.22	0.58*	0.95*	0.75
Soil Fe	0.29	0.48	-0.59	0.69	0.67*	0.28	0.54	-0.56*
Soil Mn	0.91	0.63	-0.93	0.37	-0.62	-0.19	0.66	0.91*

** = $P \leq 0.01$, * = $p \leq 0.05$

Table 12: Correlation between metals in soil and metals in water (30 – 60cm).

	Pb in H_20	Ni in H_20	Cu in H_20	Zn in H_20	Cr in H_2O	Cd in H_2O	Fe in H_2O	Mn in H_2O
Soil Pb	0.81*	0.55	0.19	-0.20	0.12	0.34	0.53	0.44
Soil Ni	0.28	0.09	-0.71	0.47	0.48	-0.24*	0.48	0.37
Soil Cu	0.34	0.22	0.42*	0.44	0.58	0.47	0.32	0.12
Soil Zn	-0.67	0.47	0.57	0.01	0.41	-0.38	0.71	0.37
Soil Cr	0.61	0.37	0.15	-0.11	0.33*	0.33*	0.31	0.38
Soil Cd	0.44	0.58	0.17*	0.61	0.17	0.49*	0.52	0.33
Soil Fe	-0.24*	0.47	-0.19	0.54	-0.11	0.66	0.09	0.57
Soil Mn	0.55	-0.39	0.31	0.17	0.71	0.12	0.21	0.32*

** = $p \leq 0.01$, * = $p \leq 0.05$

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Table 13: Correlation between metals in soil and metals in water (60 - 90cm).

	Pb in H_20	Ni in H_20	Cu in H_20	Zn in H_20	Cr in H_2O	Cd in H_2O	Fe in H_2O	Mn in H_2O
Soil Pb	-0.12	0.21	0.18	0.20	0.17	0.17	0.11	0.22
Soil Ni	0.29	0.35	-0.31	0.31	0.61	0.67	0.77	0.19
Soil Cu	0.11	0.13	-0.15	0.41	0.15	0.88	0.44	0.91
Soil Zn	0.18	0.18	0.14	-0.34	0.31	0.19	0.88	0.18
Soil Cr	0.51	-0.26	0.51	0.51	0.09	-0.11	0.71	0.21
Soil Cd	0.12	0.12	0.21	0.21	0.31	0.31	0.18	0.21
Soil Fe	0.47	0.11	0.16	0.21	0.21	0.16	0.82	-0.14
Soil Mn	0.31	0.67	0.11	0.31	0.13	0.13	0.17	0.14

** = $p \leq 0.01$, * = $p \leq 0.05$

Table 14: Correlation between metals in soil and metals in water (90 - 120cm).

	Pb in H_20	Ni in H_20	Cu in H_20	Zn in H_20	Cr in H_2O	Cd in H_2O	Fe in H_2O	Mn in H_2O
Soil Pb	-0.56	0.38	0.19	0.12	-0.38	0.31	-0.19	0.28
Soil Ni	0.56	0.54	0.38	0.55	0.22	0.22	0.13	0.33
Soil Cu	-0.12	0.52	-0.57	0.60	0.16	0.81	0.31	0.19
Soil Zn	0.68	0.51	-0.38	0.09	0.19	0.17	0.88	0.99
Soil Cr	0.17	-0.28	0.28	0.11	0.13	0.28	0.47	-0.12
Soil Cd	-0.19	0.91	-0.37	0.31	0.28	-0.24	0.62	0.59
Soil Fe	0.27	0.39	0.88	0.42	0.21	0.50	-0.15	-0.21
Soil Mn	0.22	0.31	0.98	0.17	0.31	0.41	0.19	0.35

** = $p \leq 0.01$

Effects of Organic and Inorganic Fertilizers on the Growth and Yield of Tomato

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ABSTRACT
Field trial was conducted at the Teaching and Research Farm of the Federal College of Horticulture (FCH),Dadin Kowa in Gombe Stateduring the 2017 wet season, to examine the effects of organic and inorganic fertilizers on the performance of tomato. FCH, Dadin Kowa lies between 10^0 18'N and 11^0 31' E, at an altitude 434m above sea level in the Sudan Savanna zone of Nigeria, characterized by a single peak of rainy season with rainfall of 800 mm per annum.The field experiment was laid in a randomized complete block design and replicated three times. Treatments consisted of 20t/ha of cow dung, 20t/ha of poultry manure 20kg/ha of $NPK_{15:15:15}$ and the control as T1, T2, T3 and T4 respectively. $NPK_{15:15:15}$ (T3) was split applied in two equal doses at 2 and 6 weeks after transplanting (WAT). Results of plant height, numbers of branches and leaves, leaf length, numbers of flowers and fruits per plant and total weight of fresh fruits per plant as growth and yield parameters showed significant difference (P=0.05) of treated plots over non treated ones. Highest values in growth parameters at 6WAT and yield (37.7t/ha) at harvest were recorded in plot treated with 20t/ha of poultry manure. Therefore, use of poultry manureup to 20t/haincreased tomato yield significantly. However, the field trial needs to be repeated to ascertain the superiority of the graded organic fertilizer in improving famers' tomato yieldin Dadin Kowa and related environment.
Keywords: *organic, inorganic, fertilizer, manure, transplanting*

INTRODUCTION

Productivity of crops is remarkably influenced by nutrients management (Dantata, 2011). However, organic and inorganic fertilizers supply nutrients to soil in different ways. Organic fertilizers create a healthy environment for the soil over a long period of time, while inorganic fertilizers work much more quickly, but fail to create a sustainable environment. Use of inorganic fertilizers for crops is not so good for health because of residual effects but in the case of organic fertilizers such problems do not arise but rather increases the productivity of soil as well as crop quality and yield. The use of organic inputs such as crop residues, manures and compost has great potential for improving soil productivity and crop yield through improvement of the physical, chemical and microbiological properties of the soil as well as nutrient supply (Stone and Elioff, 1998).

Tomato is an herbaceous, usually sprawling plant in the *Solanaceae* or nightshade family, grown widely for its edible fruits. It has become a major world food crop in less than a century. It is considered a vegetable but actually a fruit and is native to the Americans. It is believed to have been domesticated in Mexico, where a variant of the wild cherry tomato was brought into cultivation as early as 700 AD. Tomatoes grow well in many types of soil but prefer deep, fertile, well-drained soil that is amply supplied with organic matter and is slightly acidic.

In Nigeria, tomato crops are grown during both the wet and dry seasons but they attract higher profits during the dry season when the demand is higher than the supply. Tomato plays a vital role in human diet and is a good source of vitamins and minerals. The fruits are eaten raw or cooked and can be processed into sauce, soup, juice, ketchup, puree, paste and powder (Olaniyi and Ajibola, 2008). Especially in northern Nigeria, the fruits are sliced and dried for sale. Tomato crops require nutrient elements (N, P, K, Mg,

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Ca, Na and S etc.) as fertilizers for cultivation (Dantata and Oseni, 2009). These nutrients are specific in function and must be applied precisely in adequate amount for proper growth and development (Adekiya and Ojeniyi, 2002; Dantata*et al.,* 2006; Dantata*et al.,* 2008).

Effective fertilizer in tomato, whether organic or inorganic, provides nutrients needs at different stages of growth and development. Formaximum productivity, tomatoes need to be fertilized as in other vegetables (Dantata, 2011; Akanbi and Togun, 2002;Katung*et al.,* 2005;Dantata*et al.,* 2016). There are two groups of crop nutrients: organic manures and chemical fertilizers. Poultry manure is a very valuable kind of manure as plants can easily absorb the nutrients from it. Chemical fertilizers (except for calcium) do not improve the soil structure but enriches the soil by adding nutrients. For sustainable crop production, integrated use of organic and inorganic fertilizers has proven to be highly beneficial to mitigate the deficiency of many macro and micronutrients in fields that continuously received only N, P and K fertilizers. Various studies have confirmed that combining organic and inorganic fertilizers have proved effective in increasing productivity than being used singly (Palm, 1995; Sutanto *et al.,* 1993; Prasithikhet *et al*., 1993;Dantata, 2011;Quansah*et al*., 1998; Dantata*et al.,* 2016).

FAO (1993) reported that soil fertility replenishment for sustaining crop productivity should use all possible sources of plant nutrients in an integrated manner. Increase in human population has resulted in increased pressure on land and soil resources due to increase in cultivation of crops to meet the ever growing food demand. Increase in pressure on the soil from intensive tillage coupled with unsustainable methods of farming such as continuous cropping results in higher outflow of nutrients which could lead to depletion of soil fertility. Soil-nutrient capital is gradually depleted when farmers are unable to sufficiently compensate losses by returning nutrients to the soil via crop residues, manures and mineral fertilizers. Depletion in soil fertility results in low production of food which could be a threat to the food security of the nation and a drawback to the attainment of the Millennium development goal one; eradicate extreme poverty and hunger by the year 2015.

Soils in Nigeria are inherently low in fertility and require external inputs to improve their fertility. The use of mineral fertilizer is the most effective and convenient way to improve soil fertility (MFA, 1998). Nigerian soils have consequently shown a negative balance in nutrient budget which poses a great threat to sustainable soil management for increase in growth and crop yield (FAO, 2004). To achieve sustained soil productivity and subsequent increase in crop growth and yield calls for the exploitation of varied alternative sources of soil fertility improvement and management strategies. Soil fertility replenishing strategies that are conventionally employed are the application of nutrients in the form of either organic or inorganic manure.

In Nigeria, many farmers resort to the use of inorganic fertilizers than is the case with organic manure. However, farmers are now showing interest in organic farming because they are more aware about the residual effect of chemical substances used in the crop field and their degrading impact on the environment. Besides, the excess application of inorganic fertilizer also causes hazard to public health. But the application of both organic and inorganic fertilizer combined, can increase the yield as well as keep the environment sound (MoFA, 1998).

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Available research findings (Sutanto *et al.,* 1993; Prasithikhet *et al*., 1993; Palm 1995; Quansah *et al*., 1998) indicate that integrated plant nutrition, the combined use of organic and mineral fertilizers increases crop yield more than either used alone. Not much research has been conducted on the extent to which organic and inorganic manure affect growth and yield of crops. It is against this background that this study was conducted to evaluate the effects of organic and inorganic manure ($NPK_{15:15:15}$) on the growth and yield of tomato.

MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of Federal College of Horticulture Dadinkowa, in Gombe State, Nigeria. The experimental site is located at latitude 10^0 18'N and E longitudes 11^0 18'E at an altitude 434m above sea level. The station lies in the Sudan Savanna belt characterized by a single peak of rainy season with an average rainfall of 800 mm. The mean daily temperatures are 30^0 and 36^0 (Kowal and Knabe, 1979).

Application of the treatments

The tillage operations include ploughing and preparation of beds to conserve the soil and its nutrients (Olaniyi, 2007). The experimental was marked out into 12 plots each measuring 2m×3m and each plot was separated by 0.5m and 1m in between three blocks. Treatments consisted of 20t/ha of cow dung, 20t/ha of poultry manure and200kg/ha of $NPK_{15:15:15}$ and a control. These were applied and incorporated into the soils on the plots according to design three week before transplanting.$NPK_{15:15:15}$fertilizer at 200 kg/ha applied as split dose at two and six weeks after transplanting. The experiment was laid out in a randomized complete block design (RCBD) replicated three times. The tomato (*Solanum lycopersicon*) Roma VF seedlings were raised in a nursery, watered twice daily and transplanted 25 days after germination onto farm beds. Transplanting was done when seedlings were about 15 cm high with about 5-6 leaves. Transplanting activities was done late afternoon to prevent transplanting shock at 45 cm between rows and 45 cm within rows.

Data collection and analysis

Data were collected on growth and yield parameters to assess the influence of the various treatments on these parameters. Data were taken on the five tagged randomly sampled plants per plot. The parameters measured include plant height, number of stem branches, number of leaves and leaf length, number of flowers per plant, number of fruits per plant and total weight of fresh fruits per plant at harvest.

The data collected were subjected to a one-way Analysis of Variance (ANOVA) to determine the differences in growth and yield for the various treatments. Means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Effects of organic manure and $NPK_{15:15:15}$ fertilizer on growth parameters of tomato

Number of leaves

The results on the effects of organic manure and NPK fertilizer on the number of leaves of tomato is presented in Table 1. The results showed that a significant difference ($P<0.05$) was observed among the treatments at 2, 4 and 6 weeks after transplanting (WAT) but was not significant at 8 WAT. Among all the treatments, T_1 (cow dung manure) performed better in the 2 and 4 WAT with values of 7.95 and 12.48 respectively, while T_2(poultry manure) had the highest number of leaves (28.19 and 38.61) at 6 and 8 WAT. Generally, all the treatments performed better, than the control-treatment which had the least values throughout the growth periods.

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The increase in number of leaves of tomato could be due to the contribution made by the manure which increased the fertility status of the soils and adequate moisture as there was low moisture in the soil which could not promote the growth of the crop (Saidu*et al.,* 2011). Manure when decomposed increases both macro and micro nutrients as well as enhances the physical and chemical properties of the soil; this led to its high vegetative growth (Saidu*et al.*, 2011).

Plant height (cm)

The result of the effect of organic manure and NPK $_{15:15:15}$fertilizer on the plant height is presented in Table 2. The result indicated that there were no significant (P>0.05) differences among the treatments at 2 and 4 WAT. However, highly significant (P<0.05) differences existed among the treatments at 6 and 8 WAT. Cow dung manure showed significant influence on the plant height. Plants treated with poultry manure recorded the highest significant heightof 23.28 cm at 2 WAT but were superseded by cow dung and NPK $_{15:15:15}$ at 4 WAT. At 6 and 8 WAT however, plants treated with cow dung maintained the highest trend of 59.44cm and 69.54 cm respectively, compared to all other treatments and the control. This finding is however not in agreement with the works of Saidu*et al.*, 2011; Tiamiyu*et al.*, 2012 that tomato grown on poultry manure and sown at the right time performed better in terms of plant height of the plant than the other sources of organic manure.

Table 3 presents the results of the effects of organic manure andNPK$_{15:15:15}$ on the stem girth of tomato plant. The result showed significant (P<0.05) differences among the treatments during the first four weeks of the plant growth but did not differ significantly at 6 and 8 WAT. From the results obtained, plants treated with poultry manure gave the highest values at 2, 4 and 8 WAT (1.48cm, 2.40cm and 4.23cm) respectively. Poultry manures are known to supply adequate nutrient to the soil, precipitate rapid vegetative growth in crops (Agbede and Kalu, 1995; Aiyelaagbe*et al.,* 2005; Katung*et al.*, 2005).

The results presented in Table 4 shows the effects of organic manure and NPK $_{15:15:15}$ on the number of branches of tomato plant. The results indicated that there were no significant (P>0.05) differences among all the treatments at 2 WAT but highly significant at 4 and 6 WAT. The results also revealed that poultry manure was more superior among the treatments at 2, 4 and 6 WAT with values of 1.14, 1.83 and 2.61. However, cow dung manure performed more excellent at the 8 WAT with the highest number of branches of 3.59. Control treatment, however, had the least number of branches (3.11) compared to all other treatments.

Poultry manures gave the highest number of branches. The same trend was also observed between the cow dung and control. The behavior in the number of branches observed in the study agreed with the earlier report made by Dantata*et al.* (2011).

Effects of organic manure and NPK$_{15:15:15}$ fertilizer on yield parameters of tomato

Number of flowers per plant

Table 5 shows a significant difference at P<0.05 among means due to organic manure and NPK $_{15:15:15}$at 4, 6 and 8 WAT. The control of no manure applied significantly produced the least means on number of flowers whereas poultry manure significantly produced the highest means throughout the sampling periods on number of flower per plant. The results of this study is in accordance with the previous studies on tomato by Shi *et al.* (2004), Li *et al.* (2009), Shao and Huang (2010), Ye *et al.* (2004) and Tang *et al.* (2008).

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Number of fruits and fruit yield (t/ha)

The results in Table 6 indicated that there were highly significant ($P<0.05$) differences between the treatments at 8 and 10 WAT. Poultry manure showed significant effects (5.29) on the number of fruits compared to other treatments. Moreover, the control treatment had the least (3.09) effects on the tomato fruits. Similarly, fruit yields followed the same trend. The increase in fruit yield of tomato due to poultry manure could be attributed to easy dissolution effect of the manure. The results obtained were in agreement with the findings of Saidu*et al*.(2011), Tiamiyu*et al*.(2012), Ekwu and Nwokwu (2012). Theseworkers reported that higher yield response of crops due to organic manure application could be attributed to improved physical and biological properties of the soil resulting in better supply of nutrients to the plants. All the nutrients supplied by the different manure sources might have been diverted to vegetative growth (Saidu*et al*., 2011; Tiamiyu*et al.*, 2012).

CONCLUSION

Productivity of tomato was more influenced by 20 t/ha poultry manure than20 t/ha cow dung and 200kg/ha NPK $_{15:15:15}$ respectively.Highest values in most of the parameters measured were fromtomato plants treated with the graded level of poultry manure than others. Results obtained further revealed that tomato responded well to application of 20 t/ha of poultry manure compared to 20 t/ha of cow dung and 5t/ha NPK $_{15:15:15}$ in Dadin Kowa.Based on our finding, it is therefore, recommended that the use of organic material such as poultry manure up to 20 t/ha in the cultivation of tomato cv Roma VF should be encouraged among tomatogrowers, looking at the availability and abundance of the local material as well as cost of mineral fertilizers in the open market.

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Table 1: Effects of organic manure and NPK $_{15:15:15}$ fertilizer on the number of leaves of tomato at 2, 4, 6 and 8 weeks after transplanting in Dadin Kowa in 2017 wet season

Treatments	Number of leaves			
	Weeks after transplanting			
	2	4	6	8
T1	7.95	12.48	25.10	36.56
T2	7.73	12.42	28.19	38.61
T3	7.48	12.47	26.73	37.85
T4	6.10	10.93	22.25	33.73
Mean	7.32	12.08	25.57	36.68
P of F	0.004	0.033	0.017	0.102
Level of significance	*	*	*	NS
$LSD_{0.05}$	0.758	1.096	1.288	4.121

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control, NS. Not significant, *Significant at 5%

Table 2: Effects of organic manure and NPK $_{15:15:15}$ fertilizer on the plant height (cm) of tomato at 2, 4, 6 and 8 weeks after transplanting in Dadin Kowa in 2017 wet season

Treatments	Plant height (cm)			
	Weeks after transplanting			
	2	4	6	8
T1	21.83	29.90	59.44	69.54
T2	23.28	29.58	54.14	66.08
T3	22.08	30.29	50.01	60.44
T4	20.47	29.72	38.78	50.09
Mean	21.92	29.87	50.59	61.54
P of F	0.100	0.983	<0.001	<0.001
Level of significance	NS	NS	**	**
$LSD_{0.05}$	2.207	4.640	5.071	4.938

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control, NS. Not significant, **Significant at 0.01%

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Table 3: Effects of organic manure and NPK $_{15:15:15}$ fertilizer on the stem girth (cm) of tomatoat 2, 4, 6 and 8 weeks after transplanting in Dadin Kowa in 2017 wet season

Treatments	Stem girth (cm)			
	Weeks after transplanting			
	2	4	6	8
T1	1.39	2.39	3.22	4.10
T2	1.48	2.40	3.20	4.23
T3	1.40	2.25	3.20	3.90
T4	1.28	2.04	2.77	3.73
Mean	1.39	2.27	3.13	3.99
P of F	0.042	0.022	0.211	0.432
Level of significance	*	*	NS	NS
$LSD_{0.05}$	0.1156	0.2186	0.5898	0.742

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control, NS. Not significant, *Significant at 5%

Table 4: Effects of organic manure and NPK $_{15:15:15}$ fertilizer on the number of branches of tomato at 2, 4, 6 and 8 weeks after transplanting in Dadin Kowa in 2017 wet season

Treatments	Number of branches			
	Weeks after transplanting			
	2	4	6	8
T1	1.07	1.76	2.53	3.59
T2	1.14	1.83	2.61	3.38
T3	1.12	1.58	2.01	3.17
T4	1.04	1.42	1.80	3.11
Mean	1.09	1.65	2.24	3.31
P of F	0.078	<0.001	<0.001	0.350
Level of Significance	NS	**	**	NS
$LSD_{0.05}$	0.0861	0.1111	0.1708	0.6602

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control, NS. Not significant, **Significant at 0.01%

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Table 5: Effects of organic manure and NPK $_{15:15:15}$ fertilizer on the number of flowers of tomato at 52, 54, 56 and 58 days after transplanting in Dadin Kowa in 2017 wet season

Treatments	Number of flowers			
	Days after transplanting			
	52	54	56	58
T1	3.84	3.53	3.58	3.76
T2	3.84	4.39	3.87	4.31
T3	3.22	3.32	3.54	3.81
T4	2.05	2.87	2.81	2.99
Mean	3.24	3.53	3.45	3.72
P of F	<0.001	0.031	0.006	0.022
Level of significance	**	*	**	*
$LSD_{0.05}$	0.388	0.902	0.457	0.718

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control,
*Significant at 5%, **Significant at 0.01%

Table 6: Effects of organic manure and NPK $_{15:15:15}$ on the number of fruits of tomato at 8, 10 weeks after transplanting and fruit yield (t/ha) in Dadin Kowa in 2017 wet season

Treatments	Number of fruits		Fruit yield (t/ha)
	weeks after transplanting		
	8	10	
T1	3.82	4.45	31.1
T2	4.59	5.29	37.7
T3	3.80	4.39	25.0
T4	2.47	3.09	24.0
Mean	3.67	4.31	29.6
P of F	0.011	0.025	0.187
Level of significance	*	*	NS
$LSD_{0.05}$	1.000	1.220	14.47

T_1. 20t/ha Cow dung, T_2. 20t/ha Poultry manure, T_3. 5t/ha NPK $_{15:15:15}$, T_4 Control,
*Significant at 5%, NS. Not significant

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Effect of NPK 20-10-10 Fertilizer Rates on the Performance of Carrot (*Daucus carota* L.) at Samaru, Zaria

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Abstract
A field trial was conducted during the 2018 cropping season atthe Teaching and Research Farmof Samaru College of Agriculture, Ahmadu Bello University, Zaria in the Northern Guinea Savannah Ecology to determine the ''effect of NPK 20-10-10 fertilizer rates on the performance of carrot (Daucus carotaL.) at Samaru, Zaria''. The trial was laid out in a randomized completely block design (RCBD) with five treatments; 0, 90, 120, 150 and 200 kg ha^{-1} of NPK 20-10-10 fertilizer, replicated four times to give a total of 20 plots. The crop established very well, all cultural practices were executed as at when due. Data was collected on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total shoot yield ha^{-1}. All data collected was analyzed statistically using statistical analysis system software version 8. Means were compared using Duncan's multiple range test at 5% level of probability. The effect of NPK 20-10-10 fertilizer rates on the performance of carrot were significant on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, leaf area plant^{-1}, fresh total shoot yield plant^{-1} and fresh total shoot yield ha^{-1}. Application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer rate produced significantly higher growth and fresh total shoot yield of carrot, while the control produced significantly lower similar traits.
Keywords: *Carrot, NPK 20-10-10 fertilizer, rates, growth, fresh total shoot yield.*

INTRODUCTION

Carrot (*Daucus carota* L.) is an important vegetable which is ranked third among the succulentvegetables in the world (Dawuda *et al*., 2011). In Nigeria, it is also one of the exotic vegetableswith high value and great demand in urban centres and it is a potential export crop (Abdel-Razik, 1996; Dawuda *et al*.,2011). The edible roots are nutritious and contain water, protein, ash, vitamins and mineral (Dawuda *et al*., 2011). Carotene which is extracted from the roots is used in colouring margarine and for improving the colour of egg yolk when added to layer feed. The leaves and mature roots are used in the preparation of animal feed (Mehedi*et al*., 2012). Carrot which belongs to the family Apiaceae isa biennial and is usually cultivated as an annual crop in the tropics (Alom, 2004; Mehedi *et al*., 2012). The cropis tolerant to soil pH of 5.5 to 6.5 and it requires a deep and well-drained loamy soil with high amount of organic matter (Mehwish*et al*., 2016). Haque, (1999); Vithwel and Kanaujia (2013) recommended the application of 70-120 kg ha^{-1} N, 30- 35 kg ha^{-1} P and 0-55 kg ha^{-1} K for high yield of carrots. Production of carrot could be increased significantly through increase of per hectare yield. This can be done in many ways, of which the most important one is the judicious application of different fertilizers and manures. Among various factors responsible for low production of carrot, nutrient management is of prime importance for maintaining higher yield and soil fertility. It has been reported that neither the chemical fertilizer alone nor the organic manure are able to sustain the crop productivity and soil fertility (Hossain, 2005; Vithwel and Kanaujia, 2013). The increasing use of chemical fertilizers to increase vegetable production has been widely recognized but its long run impact on soil health, ecology and other natural resources are detrimental which affect living organisms including beneficial soil microorganism and human being. The escalating prices of chemical fertilizers and its detrimental impact on the soil, environment and human health urged them

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farmer to adoptorganic sources of plant nutrient that would offer the crops a sustainable production and soil fertility (Alam*et al.*, 2010). Besides fertilizers, there are several sources of plant nutrients like organic manures, bio-fertilizers etc. These nutrients sources not only reduce quantity of chemical fertilizers but also improve soil fertility (Kropisz, 1992; Mehedi*et al.*, 2012). The use of organic manures in helps mitigating multiple nutrient deficiencies. Application of organic manures to acidic soil reduces the soluble and exchangeable Al temporarily by forming complex and provides better environment for growth and development in plants in addition to improvement in physical, chemical and biological properties of soil in plants (Mehedi *et al.*, 2012). Bio-fertilizers have also emerged as promising components of nutrient supply system. Application of bio-fertilizers which is environment friendly and low cost input, with organic and inorganic fertilizers as part of an integrated nutrient management strategy and play significant role in plant nutrition.

The yield and yield contributing characters of carrot were influenced by the application of NPK fertilizers. The highest marketable yield was obtained by the application of NPK fertilizers at 140 kg, 40 kg and 80 kg ha^{-1} respectively (Parwaiz *et al.*, 2014). Nitrogen at 200 kg ha^{-1} produced the tallest plant, maximum number of leaves, cracked roots, branched roots and fresh shoot weight but nitrogen at150 kg ha^{-1} produced the maximum root length, root diameter, fresh root weight and the highest yield 53.37 tons ha^{-1}(Uzma and Fozia, 2014). But indiscriminate use of inorganic fertilizer changes physical, chemical and biological properties of soil and creates problem to the environment andhealth hazards due to the toxic residual effects. Application of different manures increases the yield of carrot. The highest gross and marketable yields (67.47 and 60.93 t ha^{-1}) were obtained from the treatment of inorganic fertilizers (290 kg Urea, 225 kg TSP and 250 kg MP) plus 5 t MOC ha^{-1} (Rumpel *et al.,* 1998; Alam *et al.*, 2010). Organic manures like cowdung improves soil texture, structure and aeration. Inorganic fertilizer in combination with organic manures also increases the carrot yield (Vieira *et al.,* 1998; Mehwish*et al*., 2016). A large number of scientists have studied the effect of organic manures on growth and yield of carrot.Application of 300-450 kg ha^{-1} NPK 20-10-10 fertilizer before planting has been recommended for improved growth and shoot yield of the carrot by Dawuda *et al.* (2011). Habimana *et al.* (2011) has recommended the application of 10-20 t ha^{-1} poultry manure for improved growth and yield of carrot in the tropics. The average yield of carrot estimated at 8-12 t ha^{-1} for the tropics is far below the world average estimated at 21 t ha^{-1} (Vithwel and Kanaujia(2013) have attributed the low yield of horticultural crops in the tropics to poor soil fertility.

Farmers in Nigeria especially Zaria, have not adopted a particular rate of NPK 20-10-10 fertilizer application; some apply higher rates, while others apply lower rates. This variation in the rates of NPK 20-10-10 fertilizer application has not resulted into yield increases in carrot. Therefore, optimum rate of NPK 20-10-10 fertilizer application or any source of nutrition in carrot would increase the growth, yield and quality as well.The objective of the study was to determine the optimum rate of NPK 20-10-10 fertilizer application that would optimize its use as source of nutrient for carrot growth and yield in Samaru, Zaria.

MATERIALS AND METHODS

Site Location

The experiment was conducted at the Teaching and Research Farm ofSamaru College of Agriculture, Ahmadu Bello University, Zaria located in the northern

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guinea savanna zone, situated on Latitude $11^0 11$\`N and Longitude $07^0 38$\`E at an altitude of 686m above sea level. The area has a tropical wet and dry climate with mean annual temperature and rainfall of 29^0C and 900mm-1000mm, respectively (Field Survey, 2018).

Experimental Design and Treatments

The experimental design used was randomized complete block design (RCBD), consisting of five treatments; NPK 20-10-10 fertilizer application rates at 0, 90, 120, 150 and 200 kg ha^{-1} and was replicated four times.

Sowing and Crop Management

Seeds of carrot (*Daucus carota* L.*)* was sown in the field at the rate of three seeds $hole^{-1}$ which were later be thinned to two seedlings $hole^{-1}$.

Data Collection

Data was collected in the field on plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$, leaf area (cm^2) $plant^{-1}$, fresh total shoot yield $plant^{-1}$ (gm), fresh total shoot yield ha^{-1} (kg).

Statistical Analysis

All data collected were analyzed statistically using statistical analysis system (SAS) software version 8. Means were separated using the least significant difference (LSD)at 5% level of probability (Rangaswamy, 2010).

RESULTS

Soil Physical and Chemical Analysis usedfor the Experiment

Table 1 shows the physical and chemical analysis of the soil used for the trial during the 2018 cropping season. The soil contains a higher proportion of sand (46%), higher silt (58 %), low clay (7.00 %) and moderate organic carbon (1.24%). The chemical analysis also show that pH in water was (6.59), the total nitrogen was low (0.142 %), low available phosphorus (32.33ppm), low available potassium (0.33 mg kg^{-1}), low available calcium (3.78 mg kg^{-1}), low available sodium (0.77 mg kg^{-1}), low available magnesium (1.42 mg kg^{-1}) and low cation exchange capacity (7.22 mg kg^{-1}).

Plant height (cm)

Table 2 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on plant height. At 4WAS, there was no significant difference ($P>0.05$) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference ($P<0.05$) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1}significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference ($P>0.05$) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on plant height.

Number of leaves plant^{-1}

Table 2 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on number of leaves $plant^{-1}$. At 4WAS, there was no significant difference ($P>0.05$) among the treatment means due to NPK 20-10-10 fertilizer rates on number of leaves $plant^{-1}$, however, at 6 and 8 WAS, there was a significant difference ($P<0.05$) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference ($P>0.05$) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on number of leaves $plant^{-1}$.

Number of branches plant^{-1}

Table 3 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on number of branches $plant^{-1}$. At 4WAS, there was no significant difference ($P>0.05$) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference ($P<0.05$) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at

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200 kg ha^{-1}significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference (P>0.05) between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on number of branches plant^{-1}.

Leaf area (cm^2) plant^{-1}

Table 3 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on leaf area plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on leaf area plant^{-1}.

Fresh Total Shoot Yield (gm) Plant^{-1}

Table 4 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on fresh shoot yield plant^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on fresh shoot yield plant^{-1}.

Fresh Total Shoot Yield (kg) ha^{-1}

Table 4 shows the effect of NPK 20-10-10 fertilizer on the performance of carrot in 2018 cropping season on fresh shoot ha^{-1}. At 4WAS, there was no significant difference (P>0.05) among the treatment means due to NPK 20-10-10 fertilizer rates, however, at 6 and 8 WAS, there was a significant difference (P<0.05) among the treatment means due to fertilizer rates. NPK 20-10-10 fertilizer at 200 kg ha^{-1} significantly produced higher mean values over the rest of the treatments which was followed by 150 kg ha^{-1} but there was no significant difference between 120, 90 and 0 kg ha^{-1} of NPK 20-10-10 fertilizer rates on fresh shoot ha^{-1}.

DISCUSSION

Crop performance is usually limited by inadequacy of essential nutrients. The results of this trial highlighted the effect of NPK 20-10-10 fertilizer rates in terms of growth and fresh totalshoot yield ha^{-1} of in the field carrot. The consistently poor performance of carrot in the control plots of no NPK 20-10-10 fertilizer applied showed that when nutrients are available in adequate amounts, there is tendency for plants to produce at their optimum potential. The results of this experiment showed that NPK 20-10-10 fertilizer application especially at 200 kg ha^{-1} significantly influenced growth and fresh total yield of carrot. Application of NPK 20-10-10 fertilizer rates improved growth attributes of carrot. The highest value for growth traits were equally maintained by the application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer. Also, growth characters were also considerably improved by the application rates of 0, 90, 120 and 150 kg ha^{-1} of NPK 20-10-10 fertilizer. This kind of positive influence of NPK 20-10-10 fertilizer on carrot fresh total yield had been reported by Mehedi *et al*. (2012); Dawuda*et al.* (2011). Dawuda*et al.* (2011); Mehwish *et al.* (2016) who indicated that higher dry matter production at higher rates of NPK 20-10-10 fertilizer favoured the development of plants which resulted into the production of more fruits in okra. When nutrients were available in the right proportion, the photosynthetic activity of plants were considerably favoured. This improved light interception, dry matter

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production, accumulation and partitioning (Habimana*et al.,* 2011). Significant enhancement of shoot production by carrot with NPK 20-10-10 fertilizer application corroborates the report of (Uzmaand Fozia, 2014 on potato; Vithwel and Kanaujia, 2013) on carrot. This was linked to the positive effect of adequate amount of nutrients for plant use. Nutrients such as N, P and K improved the vegetative growth, synthesis and translocation of photosynthate from the sources to the sink and significant increase in fresh shoot yield of carrot (Mehedi*et al*., 2012). Application of 200 kg ha^{-1} gave the highest fresh total yield ha^{-1}, while the control gave the lowest fresh total yield ha^{-1}. This implied that adequacy in the supply of nutrients was necessary for optimum carrot growth and fresh total shoot yield.

CONCLUSION

From the results, it was observed that the effect of NPK 20-10-10 fertilizer on the performance of carrot were significant at 6 and 8WAS in the field on plant height, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, leaf area $plant^{-1}$, fresh total shoot yield $plant^{-1}$and fresh total yield ha^{-1}. Application of 200 kg ha^{-1} of NPK 20-10-10 fertilizer produced significantly higher growth and fresh shoot yield, while the control significantly produced lower similar traits.Farmers who are into carrot production in Samaru-Zaria, are advised to use NPK 20-10-10 fertilizer rate of 200 kg ha^{-1}because it produced significantly higher growth and fresh total shoot yield than the other treatments.

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Table 1: Physical and Chemical Analysis of the Soil from the Experimental Site during the 2018 Cropping Season.

Composition	Value
% Clay	7.00
% Silt	58
% Sand	46
Textural class	Loam
pH ratio	1: 2.40
H_20	6.59
0.01M $CaCl_2$	6.22
% OC	1.24
% TN	0.142
AP (ppm)	32.33
Exchangeable Bases (Cmol kg^{-1})	
Ca	3.78
Mg	1.42
K	0.33
Na	0.77
CEC	7.22

Source: Department of Soil Science, Faculty of Agriculture, ABU Zaria

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Table 2: Effect of NPK Fertilizer 20-10-10 Rates on Growth Parameters of Carrot at Samaru, Zaria.

	Plant height (cm)			Number of leaves plant^{-1}		
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	3.92	4.27	5.82	1.45	2.22	3.41
90	3.84	4.33	6.34	2.43	2.24	3.68
120	3.97	4.37	6.62	2.54	2.26	3.78
150	3.99	5.51	7.19	2.66	3.33	4.21
200	3.91	5.79	7.88	2.72	3.48	5.34
LSD	2.84	0.27	0.30	2.81	0.24	0.31

Table 3: Effect of NPK Fertilizer 20-10-10 Rates on Growth Parameters of Carrot at Samaru, Zaria.

	Number of branches plant^{-1}			Leaf area (cm^2) plant^{-1}		
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	1.12	2.13	3.34	22.01	22.33	23.81
90	1.25	2.21	3.84	23.12	24.64	26.37
120	1.34	2.24	3.92	23.35	24.66	28.66
150	1.42	3.11	4.20	23.58	33.11	32.41
200	1.44	3.48	4.63	24.04	34.68	33.29
LSD	1.21	0.18	0.30	1.51	2.15	2.23

Table 4: Effect of NPK Fertilizer 20-10-10 Rates on Fresh Total Shoot Yield of Carrot at Samaru, Zaria.

	Fresh total shoot yield (gm) plant^{-1}			Fresh total shoot yield (kg) ha^{-1}		
Treatments	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
NPK Fertilizer 20-10-10 Rates (kg ha^{-1})						
0	22.16	23.24	24.26	120.04	122.24	123.61
90	22.20	23.31	24.34	123.28	124.33	216.64
120	22.32	23.34	24.36	123.38	124.74	218.87
150	22.36	24.36	25.18	123.60	133.22	312.42
200	23.41	25.34	25.23	125.12	134.84	323.38
LSD	1.12	1.18	1.20	3.32	3.35	3.42

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Effect of Black and White Polythene and Brown Paper Mulches on Evapotranspiration, Growth and Yield of Okra (*Abelmoschus esculentus* L.)

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Abstract
Increasing world population create a demand for more food and agricultural products in the face of water shortage which represents one of the most limiting factors in crop production worldwide, therefore farmers will simply need to learn how to make more food with less water.A screen house pot experiment was conducted at the Faculty of Agriculture Demonstration Farm of Nasarawa State University, Keffilocated at Shabu – Lafiato determine the effect of black and white polythene and brown paper mulches on evapotranspiration, growth and yield of okra (AbelmoschusesculentusL.). The experiment consisted of four (4) treatments (T_1 - control, T2 – black polythene, T3 – white polythene and T4 – brown paper and three (3) replicates in Randomized complete block design (RCBD). Soil was collected from the top 0 – 30 cm depth from a nearby farm, dried, sieved through a 2mm sieve and 5 kg was measured into the plastic pot with perforation at the bottom for drainage. The total amount of irrigation water applied and evapotranspiration was measured. Data were also collected on growth parameters (plant height and number of leaves) and yield parameters (fresh fruit weight).Result of the study show that black polythene mulches performed better than other treatments in conserving soil moisture, by reduced evapotranspiration (5.30 L) and higher fruit weight (106.13 g/pot). The value of plant height in the black polythene was higher compared to the other treatments with the least in the bare soil treatment at 4, 8 and 10 WAP while the brown paper had the least value at 6 WAP. The black and white polythene mulch were at par on the number of leaves and significantly different from bare soil treatment but not significantly different from brown paper treatment. Considering the overall result, it can be concluded that black polythene is recommended for water conservation and higher yield of crop.
Keywords: *Mulch, Evapotranspiration, Irrigation, Okra, Guinea Savanna.*

INTRODUCTION

With increasing population, income growth and enhanced purchasing power of people, agriculture has been under pressure to produce more to meet food requirements. Increased food production could be achieved by putting more areas under cultivation or by increasing the productivity through irrigation, cropping intensity and soil fertility enhancements(Tanwar*et al.,* 2014). One of the goals of irrigation farming is provision of the right amount of water and at the right time for plant growth and development. Consequently, it ensures sustainable agriculture with its economic benefits.

Shortage of water represents one of the most limiting factors in crop production worldwide (Mohamed, 2000). Evapotranspiration (ET) represents the major consumptive use of irrigation water and rainfall on agricultural land (Burt and Mutziger,2005) and although transpiration (T) is the portion of ET that impacts on yield, the evaporation component (E) can be a significant component of the total ET. High evaporation losses reduce the amount of available water for transpiration, resulting in reduced plant water availability and hence increased irrigation (Groenevelt and van Straaten, 1989; Yunusaand Walker, 1997).In order to increase transpiration relative to evaporation, a reduction in evaporative losses is needed. This indicates that control of evaporation is critical and needs more attention in order to increase water use efficiency.

Mulching is an agronomic practice for conserving soil moisture and reducing the rate of evaporation.The use of mulches (plastic, paper or organic materials) would greatly reduce evaporation losses from the soil surface, thereby conserving water for the plants. Mulches can be composed of

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plant materials (organic) or they may be synthetic (inorganic) consisting of plastic sheets (Allen *et al*., 1998).

Okra (*Abelmoschusesculentus*)belongs to the family Malvaceae. It is one ofthe prominent vegetable crops grown inNigeria and it is widely cultivated in thetropics. Okra is important because of itsnutritive values present in the leavesand fruits (FAO, 2008). Consequently,Vincent *et al.* (2005) said it is among the most commonly cultivated vegetables throughout Nigeria and other tropical regions because of its much liked mucilaginous or 'draw' property of the fruit and its ability to grow well under most tropical conditions.

Production of vegetables and other crops in semi-arid areas is hampered by the shortage ofwater, the major part of the growing season usually being characterized by low, erratic rainfalland high evapotranspiration rates (Unger, 1995). In this regard, water useefficiency (WUE) is crucial and should be promoted.Practices and techniques which minimize water utilization are fast evolving and there is need for evaluation of these practices before adoption. Therefore, there is the need to carry out an evaluation of the effect plastic mulch on evapotranspiration, growth and yield of okra in a screen house in Lafia, Southern Guinea Savannah of Nigeria.The objectives of this study were to determine the effect of brown paper, white and black polythene mulches on ET of Okra and to determine their effect on the growth and yield of Okra.

MATERIALS AND METHODS

A screen house pot experiment was conducted at the Faculty of Agriculture Demonstration farm located at Shabu-Lafia, Nasarawa State University, Keffi, Nasarawa State. The area is situated on latitude 8^0N and 9^0N and longitude 8^0E and 9^0E, with mean elevation of 181.53m above the sea level (NIMET, 2007). The area is characterized by a sub-humid tropical climate with wet and dry season. The annual rainfall distribution is about 1132mm. The mean annual temperature is 27^0 with mean minimum and maximum temperatures of 24.5^0 and 33^0 respectively. The pot experiment consisted of four (4) treatments and three (3) replicates in Randomized complete block design (RCBD). The treatments were represented as T_1, T_2, T_3 and T_4 respectively, where T_1 was control, T2 – white polythene, T3 – black polythene and T4 – brown paper. The experiment constituted a total of 12 pots. Soil was collected from the top 0 – 30 cm depth from a nearby farm. The soil was dried, sieved through a 2mm sieve and 5 kg was measured into the plastic pot with perforation at the bottom for drainage. The pots were 21cm in diameter and 23 cm in height. The Okra variety planted was Clemson spineless (Clemson Spineless is a uniformspineless variety with medium dark green, angular pods requiring 55 to 58 days to reach maturity). The okra was planted on 6th June, 2015 with two seed per hole and was thinned one plant per pot two weeks after planting. A standard fertilizer dose of 100 kg N, 50 kg P_2O_5 and 50 kg K_2O ha ^{1} was applied uniformly in all treatments in two equal splits after 20 and 40 days of seed germination.The mulching material were cut in a cross pattern at the point where the plant passed through and were placed on 20th June, 2015.Weeds were removed by Hand pulling on the bare soil treatment. Water was applied at an interval of three days each.

Determination of Amount of Irrigation Water Applied and Evapotranspiration

The water holding capacity (pot capacity) of each pot was determined at the beginning of the experiment. Pots were initially saturated with tap water and covered with black polythene in order to prevent evaporation and allowed to drain. The pots were then weighed. The weights

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of the pots after drainage were assumed as the pot capacity (Wpc).
The amount of irrigation water applied was determined by weighing the pots (W) just before irrigation and subtracting from the pot capacity as shown in equation (1). The amount of evapotranspiration was calculated using the water balance method (James, 1988) as shown in equation (2)

$$I = \frac{W_{pc} - W}{\rho_W} \qquad (1)$$

$$ET = \frac{W_1 + I + W_2}{\rho_W} \qquad (2)$$

Where Wpc = pot capacity weight (kg)
W = pot weight (kg)
ET = evapotranspiration in a pot (L/pot)
W_1 = pot weight just before nth irrigation (kg)
W_2 = pot weight just before (n+1)th irrigation (kg)
I = amount of irrigation water applied (kg)
P_w = water bulk density (1 kg/L)
The fruits were harvested at physiological maturity and weighed. Data collected on okra growth were obtained at interval of two weeks i.e. 4, 6, 8 and 10 WAP on each plant and yield at harvest.
The height of the plant was measured from the soil surface to the terminal bud using a meter rule. The numbers of leaves on each plant was counted manually and the mean was recorded. The weight of fruit from each plant was taken and the mean was recorded. The average fruit weight obtained from each pot was weighed and multiplied by the number of fruits from each pot.

Data Analysis
The measured plant parameters and data were subjected to one-way analysis of variance (ANOVA) using thegeneral linear model procedure of the statistical analysis system (SAS Institute, 1999).Separation of the means of the soil properties was performed using Duncan multiple range test at 5% probability level.

RESULTS

Some Physical and Chemical Properties of Pot's Soil.
The analysis carried out on the physical and chemical properties of the soil in pots for the experiment showed that the soil texture is loamy soil with pH and organic matter content values of 7.27 and 2.75, respectively. This shows a neutral soil with low organic matter content. The soil water content characteristics were – saturation (38.0 %), field capacity (15.0 %) and wilting point (7.0 %). The soil showed a low cation exchange capacity (Table 1).

Effect of Mulch on Water Applied, Evapotranspiration and Weight of Fruits
Table 2 shows the total amount of irrigation water applied to the crop, the effect of the treatments on evapotranspiration and weight of fruit per plant. It shows significant difference between treatments in the amount of irrigation water applied with the bare soil having the highest value (11.80 L) and significantly different from brown paper with a value of 10.30 L. T4 was also significantly different from T2 and T3 with T2 having the least value (8.90 L).
Treatment T1 was significantly different from other treatment in the amount of evapotranspiration having the highest value (7.53 L). Treatment T4 (6.33 L) was also significantly different from T2 (5.30 L) however, both treatments were not significantly different from T3 with a value of 5.67 L.
The yield statistically showed no significant difference between the treatments. However, treatment T2 had the highest yield weight (106.13 g/pot) followed by treatment T3 with a value of 99.57 g/pot while T1 had the least value (85.10 g/pot).

Effect of Mulch on Plant Height
Table 3 shows thatat 4 WAP, the plant height between the treatments were not significantly different, however, the value

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of plant height in the black polythene (14.80cm) was higher compared to the other treatments with the least in the bare soil treatment (12.73cm). Similarly, at 6, 8 and 10 WAP there was no significant difference between treatments, black polythene treatment showed higher values in plant height with the least value (17.77cm) in the brown paper at 6 WAP and (23.27cm and 28.50cm) in the bare soil treatment at 8 and 10 WAP, respectively.

Effect of Mulch on Number of Leaves

Table 4 shows the number of leaves per plant.At 4 WAP, the number of leaves between the treatments was significantly different with T2 and T3 at par and significantly different from T1 but not significantly different from T4 while T4 was not also significantly different from T1, T2 and T3.

At 6 and 8 WAP there was no significant difference between treatments, however, treatments T2 and T3 values (7.33 and 10.00) were at par at the weeks, respectively while the least values (6.33 and 9.00) in the Bare soil treatment, respectively. At 10 WAP, treatments values were not significant and at par with a value of 11.67.

DISCUSSION

Effect of Mulch on Water Applied, Evapotranspiration and Weight of Fruit

The use of plastic mulch helps in conserving water byreducing evaporation from soil surface, controlling weedgrowth and reducing soil compaction. According toRamakrishna *et al*. (2006) evaporation from the soilaccounts for 25-50% of the total quantity of water used.The results of this study were in line with the findings ofAbu-Bakr and El-Balla (2003); Ban *et al*. (2009) and Kumarand Lal (2012), in which they indicated that the mainadvantage of using plastic mulch is to retain more soilmoisture.

The yield statistically showed no significant difference between the treatments. However, treatment T2 (black polythene) had the highest yield weight (106.13 g/pot) followed by treatment T3 (white polythene) with a value of 99.57 g/pot while T1 (bare soil) had the least value (85.10 g/pot). This agrees with the findings of Abu-Bakr and El-Balla(2003) which showed an increase in average pod weight by 13.7%, 6.7% and 8.6% in the black,clear and green mulches, respectively, compared to the control and totalyield increased, respectively, by 84.9%, 46.0% and 46.9% in the black, clear and green plastic mulches. Similar results were reported for okra (Wien *et al*. 1993; Mashingaidze*et al*. 1996).These effects were due to the microclimate modification by theplastic mulch. In addition to increasing soil temperature, conservingmoisture and controlling weeds, plastic mulch also affects above-groundenvironment (Tarara, 2000).

Effect of Mulch on Plant Height

Table 3 shows that the plant height between the treatments were not significantly different, however, the value of plant height in the black polythene was higher compared to the other treatments with the least in the bare soil treatment at 4, 8 and 10 WAP while the brown paper had the least value at 6. This conforms with the findings of Aminu-Taiwo*et al.,* 2014 who stated that the Plant height, stem diameter, number of leaves and leaf area were significantly ($P<0.05$) influenced by the black mulching materials. They recorded the highest plant height from the plot covered with plastic mulch which was significantly different from other mulch materials used.Mahadeen, (2014) also reported that theheightof okra plants and number of branches per plantwere significantly higher when black plastic mulch usedas compared to non-mulched treatment.

Effect of Mulch on Number of Leaves

From Table 4 the number of leaves at 4 WAP showed that the means between

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treatments was significantly different. The black and white polythene mulch were at par and significantly different from bare soil treatment but not significantly different from brown paper treatment. The brown paper treatment was not also significantly different from the other treatments.

At 6 and 8 WAP there was no significant difference between treatments, however, plastic polythene mulch treatments were at par while the least values (6.33 and 9.00) was found in the bare soil treatment, respectively. At 10 WAP, treatments values were not significant and at par with a value of 11.67. The result of this study agrees with Abu-Bakrand El-Balla (2003) findings which showed that thenumber of leaves increased by 41.5%, 22.5% and19.7%, and the dry weight of shoot increased by 68.4%, 42.0% and 38.1%in the black, clear and green mulches, respectively, compared to thecontrol. This is also in agreement with reports on watermelon (Soltani*et al*., 1995) and tomato (Taber andSmith, 2000).

CONCLUSION

The results of this study exhibited the significant effect of black polyethylene plastic mulch on soil moisture conservation during the growing season. The black plastic mulch reduced soil water evaporation and improve soil water retention. Moreover, using black polyethylene plastic mulch produced higher fruit weight and therefore, can be concluded to have performed better than white polythene, brown paper and bare soil respectively.

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Table 1: Some physical and chemical properties of pot's soil.

Property	Quantity
pH (H_2O)	7.27
Organic matter (%)	2.75
Sand (%)	89.0
Silt (%)	3.0
Clay (%)	8.0
Texture	Loamy sand
Bulk density (g/cm^3)	1.64
Soil water content (dry weight basis)	
Saturation (%)	38.0
Field capacity (%)	15.0
Wilting point (%)	7.0
N (%)	0.21
Avail. P (ppm)	6.38
Na (Cmol/kg)	0.19
K (Cmol/kg)	0.37
Ca (Cmol/kg)	3.01
Mg (Cmol/kg)	1.01
C.E.C	6.25

Table 2: Effect of mulch on water applied, evapotranspiration and weight of fruit.

Treatment	Water Applied (L)	Evapotranspiration (L)	Yield (g/pot)
Control (T1)	11.80^{a}	7.53^{a}	85.10^{a}
White polythene (T2)	8.90^{c}	5.30^{c}	106.13^{a}
Black polythene (T3)	9.37^{c}	5.67^{bc}	99.57^{a}
Brown Paper (T4)	10.30^{b}	6.33^{b}	93.03^{a}
Mean	10.09	6.21	95.96

*Means with the same letter(s) within a column are not significantly different at $p \leq 0.05$

Table 3: Effect of mulch on plant height (cm)

Treatment	4 WAP	6 WAP	8 WAP	10 WAP
Control (T1)	12.73^{a}	18.50^{a}	23.27^{a}	28.50^{a}
White polythene(T2)	14.80^{a}	19.57^{a}	25.40^{a}	29.60^{a}
Black polythene(T3)	13.43^{a}	19.17^{a}	24.13^{a}	29.27^{a}
Brown Paper(T4)	13.03^{a}	17.77^{a}	23.50^{a}	29.06^{a}
Mean	13.50	18.75	24.08	29.09

*Means with the same letter(s) within a column are not significantly different at $p \leq 0.05$

Table 4: Effect of mulch on number of leaves.

Treatment	4 WAP	6 WAP	8 WAP	10 WAP
Control (T1)	4.00^{b}	6.33^{a}	9.00^{a}	11.67^{a}
White polythene(T2)	5.33^{a}	7.33^{a}	10.00^{a}	11.67^{a}
Black polythene(T3)	5.33^{a}	7.33^{a}	10.00^{a}	11.67^{a}
Brown Paper(T4)	4.67^{ab}	6.67^{a}	9.67^{a}	11.67^{a}
Mean	4.83	6.92	9.67	11.67

*Means with the same letter(s) within a column are not significantly different at $p \leq 0.05$

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Response of Maize (*Zea mays* L.) to Integrated Use of Liquid Organic NPK, Inorganic NPK and Micronutrients Fertilizers in the Sudan Savannah Zone of Nigeria

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Abstract
Research was conducted during 2016 rainy seasons at the research farm of Binyaminu Usman Polytechnic, Hadejia, Jigawa State (latitude 12^0 22′ N and longitude 7^0 46′ E) to assess the influence of liquid organic and inorganic NPK fertilizers, micronutrients and integrated nutrients management on the yield and yield components of maize. The treatments comprised of inorganic NPK fertilizer (120::60:60kg ha^{-1}) alone or with micronutrients, liquid organic NPK fertilizer (LOF) alone (5 lit.ha^{-1}) or with micronutrients, 25% LOF + 75% inorganic NPK, 25% LOF + 75% inorganic NPK + micronutrients, 50% LOF + 50% inorganic NPK, 50% LOF + 50% inorganic NPK + micronutrients, 75% LOF + 25% inorganic NPK, 75% LOF + 25% inorganic NPK + micronutrients, micronutrients only (300 g.ha^{-1}) and the control plot with no fertilizer. SAMMAZ 27 was used as a test crop. The treatments were laid in a Randomized Complete Block (RCB). The results showed that full inorganic NPK (120:60:60) in combination with micronutrients outperformed all the other treatments in yield characters. Liquid organic NPK alone (5 lit.ha^{-1}) was superior only to control treatment in most characters assessed. The combinations of liquid organic NPK with inorganic NPK and micronutrients fertilizers significantly affected the yield and yield components at the study area. The result further indicated that in most instances 50% LOF (2.5 lit.ha^{-1}) + 50% inorganic NPK fertilizer + 300 g.ha^{-1} micronutrients and 25% LOF (1.25 lit.ha^{-1}) + 75% inorganic NPK fertilizer + 300 g.ha^{-1} micronutrients were at par with inorganic NPK fertilizer alone (120:60:60) and inorganic NPK fertilizer + 300 g.ha^{-1} micronutrients. This showed that integrated nutrient management involving liquid organic NPK and inorganic NPK fertilizers along with micronutrients resulted in good performance of maize. The highest grain yield of 1796 kg.ha^{-1} and 1442 kg.ha^{-1}were recorded in plots treated with full inorganic NPK with micronutrients, while the lowest grain yield of 363kg.ha^{-1} and 418 kg.ha^{-1}were recorded from control plots.

INTRODUCTION

Maize (*Zea mays* L.) is an annual crop belonging to the genus *Zea* and family Poaceae.. Maize is an important cereal crop in the world and ranks third, following wheat and rice in the world's cereal crops production (ref.). Maize is consumed directly by man as a source of dietary carbohydrate and is used to feed livestock. It also serves as raw materials for pharmaceutical and other industries, (USDA, 2005). The objectives of this study were determine the influence of liquid organic NPK fertilizer on the performance of maize and evaluate the effect of combined use of liquid organic, inorganic and micronutrient fertilizers on the growth and yield of maize Abdurrahman (2006)

MATERIALS AND METHODS

The experiment was conducted at Binyaminu Usman Polytechnic Farm, Hadejia, Jigawa State (Latitude 12^0 22′ N and Longitude 7^0 46′ E) during 2016 raining season. Composite soil samples of the experimental site was formed by collecting ten soil samples randomly at the depth of 0 – 30cm using soil auger before planting and fertilizer application. The samples were bulked together and subjected to analysis for physico-chemical properties using standard procedures (Table 1).The experiment comprised of a maize variety (SAMMAZ 27) and twelve fertilizer treatments of liquid organic NPK fertilizer (LOF), inorganic and micro-

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nutrients fertilizers combinations as described below.

i. Full inorganic NPK fertilizer (NPK 120:60:60kg ha^{-1})
ii. Full inorganic NPK fertilizer (NPK 120:60:60) + micronutrient (300g/ha)
iii. Full LOF (5litres/ha)
iv. Full LOF (5litres/ha) + micronutrient (300g/ha)
v.75% LOF (3.75l/ha) + 25% inorganic NPK fertilizer
vi.75% LOF (3.75l/ha) + 25% inorganic NKP fertilizer + micronutrient (300g/ha)
vii.50% LOF (2.5l/ha) + 50% inorganic NPK fertilizer
viii.50% LOF (2.5l/ha) + 50% inorganic NPK fertilizer + micronutrient (300g/ha)
ix.25% LOF (1.25l/ha) + 75% inorganic NPK fertilizer
x.25% LOF (1.25l/ha) + 75% inorganic NPK fertilizer + micronutrient (300g/ha)
xi. Micronutrient (300g/ha)
xii. Control (No fertilizer)

Treatments were laid out in a randomized complete block design (RCBD) and replicated four times. The land was cleared and harrowed and then ridged using Ox - driven ridger. The seeds were sown manually by hand at the rate of 2 seeds per hole at an intra and inter row spacing of 0.25m and 0.75m, respectively between stands. After germination the seedlings were thinned to 1plant/stand two weeks after sowing (WAS) to give a plant population of 53,333 plants per hectare. For the inorganic fertilizer, NPK (20-10-10) was used to supply the complete doses of P and K of each treatment and half dose of N during sowing. While the remaining half of N of each treatment was applied 4 WAS using Urea (46% N). The fertilizer was side placed between stands and buried 5cm deep. For the liquid organic NPK fertilizer and micronutrient fertilizer treatments, the quantity required for each treatment was divided into three equal doses and applied directly to the soil very close to the roots at 2 WAS and subsequently at 4 WAS and 6 WAS. The mixing ratio of the liquid organic NPK fertilizer used was 0.5 litre of liquid organic NPK to 50 litre of water as recommended by the producer. The micronutrient fertilizer at the rate of 300g/ha was incorporated in to the mixture and applied together.

Data were collected on cob yield/hectare (kg), cob length (cm), cob diameter (mm), kernel depth (mm), number of kernel rows/cob, grains weight/cob (g), grain yield/hectare (kg), 100-grain weight (g), harvest index, shelling percentage and stover yield/hectare (kg). Data collected from the experiment was subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). Duncan Multiple Range Test (Duncan, 1955) was used to compare the treatment means when there is significant difference in between the treatments.

RESULTS

The result of physico-chemical properties of soil of the experimental site is presented in Table 1. The result indicated that the soil of the location was sandy loam, pH was moderately acidic (6.8), organic carbon was low (0.7 g/kg), organic matter content was very low (1.2 g/kg), total nitrogen was also very low (0.39 g/kg), available phosphorus was moderate (13.75 mg/kg), potassium content was also moderate (0.38 cmol/kg) suggesting the need for fertilizer amendment for maize production in the study area.

Number of kernel rows per cob

Kernel rows per cob as affected by the treatments are presented in Table 2. The results revealed a significant statistical difference ($P \leq 0.05$) between the treatments on the character. The highest number of kernel rows per cob was recorded with full inorganic fertilizer + micronutrient followed by 25% LOF + 75% inorganic fertilizer + micronutrient, full inorganic fertilizer and 50% LOF + 50 % inorganic fertilizer + micronutrient,

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Cob length (cm)

Table 3 present the effects of treatments on cob length. The results showed a significant statistical difference (P≤0.05) between the treatments as per the character. Observations revealed that full inorganic fertilizer + micronutrient, full inorganic fertilizer, 50% LOF + 50% inorganic NPK + micronutrient, 25% LOF + 75% inorganic NPK + micronutrient, and 75% LOF + 25% inorganic NPK + micronutrient were at par and produced longest cobs, followed by 50% LOF + 50% inorganic NPK, 25% LOF + 75% inorganic NPK. Moreover observations showed that application of micronutrient solely resulted in a significant difference over the control.

Grain weight per cob (g)

The effect of treatments on grain weight per cob is presented in Table 4. The results revealed that grain weight per cob was significantly (P≤0.05) affected by the treatments at the study sites. The results almost follows a unique trend, highest grain weight per cob of 124g was recorded with full inorganic NPK +micronutrient, followed by full inorganic NPK and 50% LOF + 50% inorganic NPK that yielded 111g Observations revealed that grain weight per cob recorded with treatment combinations between LOF and inorganic fertilizer were at par with that of full inorganic NPK fertilization.

Grain yield (kg ha^{-1})

The effect of treatments on grain yield per hectare is presented in Table 5. The result revealed that, grain yield per hectare was significantly affected by the treatments. Full inorganic NPK + micronutrient recorded higher grain yield/ha of 1796.29kg and 1442kg followed by full inorganic NPK without micronutrient and 25% LOF + 75% inorganic NPK with micronutrient which recorded grain yield of 1424.07kg and 1422.22kg. A grain yield differences of 79.8% was observed between full inorganic fertilizer and control. Similarly a grain yield differences of 61% between full LOF and control was also observed. Control plots recorded the lowest grain yield/ha of 362.9 kg. The results showed 292 and 198 % yield difference between full inorganic fertilizer treatments and the control and 154 and 6% yield difference between LOF and the control, The effect of micronutrient fertilization on grain yield per hectare was significant/ The results showed that grain yield per hectare was not significantly (P≥0.05) affected by micronutrient fertilization. However all treatments in combination with micronutrient recorded higher grain yield over same treatments without micronutrient**.**

DISCUSSIONS

Effect of Inorganic NPK Fertilizer on Growth and Yield of Maize

Observations recorded from this study revealed that both growth and yield characters assessed significantly increased with increase in NPK rates up to application of complete recommended rate (120:60:60 kg/ha NPK) as recommended by Edensor *et al*., (1989). The result of the experiment also revealed that application of NPK fertilizer significantly promoted yield characters of maize. This is in line with findings of Singh *et al*. (2009) who revealed that yield characters of maize were significantly higher through the application of 100% nitrogen from inorganic sources. This is due to the fact that nitrogen applied from inorganic source becomes more readily available and absorbable to the crop as compared to nitrogen from organic source that need to be decomposed and mineralized before the crop absorbed it. Moreover its known that nitrogen favourably affects maize growth through increasing cell division, expansion and elongation of all morphological parts of the crop.

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Effect of Liquid Organic NPK Fertilizer on Growth and Yield of Maize

The result of this study revealed that application of sole liquid organic NPK fertilizer significantly increased most of the growth and yield characters of maize only above the control treatment. The findings of this study revealed that growth and yield characters were significantly influenced due to application of liquid organic NPK fertilizer mostly in combination with inorganic NPK. These characters involved Number of kernel rows/cob, cob yield/ha, grain yield/ha, grain weight/cob increased significantly due to application of liquid organic NPK. The finding of this study supported the observations reported by Eureka *et al*. (2013), who carried out an experiment to assess the response of maize to liquid organic fertilizer. Their findings revealed that application of 15l/ha liquid organic fertilizer produced significant yield difference than the other rates. This could be attributed to the role played by the LOF in acting as a substrate for micro-organisms which helped in mobilization and mineralization of essential nutrients, biological stimulation of growth and plant visor and decreased in crop maturity period...

Effect of Micronutrient Fertilization on Growth and Yield of Maize

Micronutrients are essentially required by crops in small quantity and play a vital role in the plant metabolic processes (Marcher, 1995). The results obtained from this study revealed that application of micronutrient enhanced growth and yield of maize compared to treatments without micronutrient, though the differences were not statistically significant... This could be due to the fact that micronutrient are relatively required by crops in small amounts and may be supplied by the soil, and could also be attributed to the amounts of micronutrient in the LOF used in the experiment that may be enough to satisfy the requirements of the crop. The result shows that application of micronutrient fertilizer significantly enhanced some yield characters such as cob length and cob yield/ha. Results showed that there was 50.23% and 27.14% increase in cob yield between sole micronutrient and the control. This was due to the roles played by these nutrients in the plant metabolic processes which involved cell wall development, respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation.

Combined Effects of Inorganic, Liquid Organic NPK and Micronutrient Fertilizers on Growth and Yield of Maize

The result of this study revealed that, the integrated nutrients management enhanced positively the yield characters of maize, though there was no regular trend in the effects of the treatments combinations in affecting the characters evaluated in this research. In most cases application of 25% liquid organic NPK + 75% inorganic fertilizer with or without micronutrient significantly enhanced growth and development of maize over liquid organic NPK alone and control treatments. Though, almost all the treatment combinations involving the three sources of nutrients evaluated in this study had shown a positive influence on the test crop.

CONCLUSION

Based on the results obtained in this study, the use of recommended NPK fertilizer (at the rate of 120:60:60kg ha^{-1}) or 25% LOF + 75% inorganic fertilizer could be recommended for use by farmers in the study area.

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Table 1: Physico-chemical properties of soils of the experimental site 2016 raining season

Physical Composition (%)	
Sand	60.28
Silt	23.18
Clay	16.54
Textural Class	Sandy loam
Chemical Composition	
pH in H_2O	6.80
Organic Carbon (g/kg)	0.70
Total Nitrogen (g/kg)	0.39
Available Phosphorus (mg/kg)	13.75
Organic Matter (g/kg)	1.20
Exchangeable Bases (cmol/kg)	
Ca	3.69
Mg	1.17
K	0.38
Na	0.49

Analyzed in the Soil Science Department, Faculty of Agriculture, Bayero University Kano

Table 2: Effect of Fertilizer Treatments on Number of Kernel Rows per cob of Maize 2016 raining season

Treatment	Number of Kernel Rows/Cob
Full IF + man	15.25a
Full IF	14.75ab
Full LOF + mn	14.50abc
Full LOF	13.75abc
75% LOF + 25% IF + mn	14.25abc
75% LOF + 25% IF	13.75abc
50% LOF + 50% IF + mn	14.75ab
50% LOF + 50% IF	14.25abc
25% LOF + 75% IF + mn	15.00ab
25% LOF + 75% IF	14.25abc
Micronutrient	13.50bc
Control (No fertilizer)	13.00c
Level of significance	*
SED	0.669

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT
Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability

Table 3: Effect of Fertilizer Treatments on and Cob Length (cm) of Maize 2016 raining season

Treatment	Cob Length
Full IF + mn	13.47a
Full IF	13.40a
Full LOF + mn	11.32de
Full LOF	10.75ef
75% LOF + 25% IF + mn	13.25a
75% LOF + 25% IF	11.95cd
50% LOF + 50% IF + mn	13.25a
50% LOF + 50% IF	12.27bc
25% LOF + 75% IF + mn	13.22a
25% LOF + 75% IF	12.92ab
Micronutrient	12.00cd
Control (No fertilizer)	10.17f
Level of significance	**
SED	0.3274

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Table 4: Effect of Fertilizer Treatments on Cob Yield per Hectare (kg) and Grain Weight per Cob (g) of Maize at Hadejia

Treatment	**Cob Yield / Hectare**	**Grain Weight /Cob**
Full IF + mn	2155.56a	124.00a
Full IF	1708.89b	111.00ab
Full LOF + mn	1325.93cd	102.50abc
Full LOF	1040.00de	89.50bcd
75% LOF + 25% IF + mn	1411.12bc	92.80bc
75% LOF + 25% IF	1264.45cd	104.80abc
50% LOF + 50% IF + mn	1511.11bc	102.50abc
50% LOF + 50% IF	1332.59cd	111.00ab
25% LOF + 75% IF + mn	1706.67b	105.50abc
25% LOF + 75% IF	1342.22cd	88.00bcd
Micronutrient	875.56e	82.00cd
Control(No fertilizer)	435.56f	65.20d
Level of significance	*	*
SED	138.631	11.15

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT
Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability).

Table 5: Effect of Fertilizers Treatments on Maize Grain Yield (kg ha^{-1}) during 2016 raining season

Treatment	**kg ha^{-1}**
Full IF + mn	1796.29a
Full IF	1424.07b
Full LOF + mn	1175.18cd
Full LOF	922.22efg
75% LOF + 25% IF + mn	1101.85cde
75% LOF + 25% IF	850.01fg
50% LOF + 50% IF + mn	1331.48bc
50% LOF + 50% IF	1057.78def
25% LOF + 75% IF + mn	1422.22b
25% LOF + 75% IF	1118.52cde
Micronutrient	759.34g
Control (No fertilizer)	362.96h
Level of significance	*
SED	109.536

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT
Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability).

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Effects of varying rates of Pig manure on the performance of Cucumber *(Cucumis sativus* L) in Ikorodu Agro ecological zone

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Abstract
This study was carried outat the Teaching and Research Farms Lagos State Polytechnic, Ikoroduto determine the effects of different levels of pig manure on the performance of cucumber (Cucumis sativus). The experiment was laid out on Randomized Complete Block Design with six experimental treatments replicated three times.The treatments applied were 0, 5, 10, 15, 20, and 25 t/ha^{-1}. Data werecollected on vine length (cm), number of leaves, days to 50% flowering, weight of fruit (kg) number of fruits, length of fruit (cm) and width of fruits (cm). The results show that 25 t/ha^{-1} pig manure significantly ($p<0.05$) produced the highest yield, growth performance and cost effective than other treatments therefore it is recommended for the production of cucumber in Ikorodu Lagos.

Keywords: *cost effective, Cucumis sativus, highest yield, pig manure*.

INTRODUCTION

Cucumber (*Cucumis sativus L.*) is the fourth most important vegetable crop after tomato, cabbage and onion and the second most widely cultivated cucurbit after melon (Tatlioglu, 1993). Production of cucumber in Nigeria has increased probably due to awareness being created by its market demand and economic returns, short duration in maturity or due to its nutritional and medicinal values. Hence it has become a popular vegetable crop in Nigeria.

Soil degradation and nutrient depletion have become serious threats to agricultural productivity in Nigeria and most parts of Sub-Saharan Africa (Ramaru *et.al*.,2008). These degradative processes and concomitant decline in soil quality decrease the capacity of soils to produce adequate yields of healthy and nutritious crops (Parr *et.al*.,1989; FAO, 1990). To ensure improved crop yield there in need for addition of fertilizers to improve the soil fertility. Onweremadu *et. al.* (2003) and Mbagwu *et.al.* (1994) recorded increase in soil productivity as a result of using Pig manure. This could possibly be due to higher content of total N, P and K in pig manure compared to the other manure types.

Although pig manure is very cheap and effective as a good nutrient source for sustainable crop production, its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of resource poor farmers due to its high cost (Rahman, 2004). The objectives of this study is (i) to know the effect of variable rates of pig manure on the growth and yield of cucumber (*Cucumis sativus*) and(ii) the most cost effective rate of pig manure application in cucumber production.

MATERIALS AND METHODS

Experimental location and land preparation

The experiment was carried out on a total area of land measuring 236.5m^2 which has been under continuous cultivation for over three years without any forms soil amendments at the Teaching and Research Farmsof Lagos State Polytechnic, Ikorodu,and was laid out in Randomized Complete Block Design (RCBD**)**. The land was divided into 3 blocks of 21.5m x 3m

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($63m^2$), each plot size is 3m x 3m ($9m^2$) with a discard of 0.5m to give a total number of 18 plots. The land was ploughed and harrowed to obtained a fine tilt. The treatments consist of different rates of pig manure (0, 5, 10, 15, 20 and 25 t/ha^{-1}) applied to the plots two weeks before planting by broadcasting method to allow for mineralization and was replicated 3 times.

Crop establishment and maintenance

Cucumber seeds (Poinsett 76 variety) was obtained from agro-allied store Sabo market Ikorodu, Lagos State and planted at 2 seeds per hole spacing of 75cm x 75cm (Eifediyi and Remison, 2010), thinned to one stand each at one week after planting and supply also done to replaced missing stands to give a total of 16 plants per plot and a total of 288 plants. Other cultural practices such as weeding and insect pest control were carried out as at when due.

Pre-cropping Soil and Pig Manure analysis

Composite soil samples were randomly collected with auger from ten (10) different locations in the study area and were composited, air dried and sieved through 5mm sieve and their physiochemical characteristics were determined before application of treatment following standard laboratory procedure (Page *et al*., 1989). Pig manure was obtained from a piggery section, Farm Settlement Odogunyan, Ikorodu, Lagos State, cured, pulverized and subjected to standard laboratory procedure to determine its chemical constituents.

Data collection and Statistical Analysis

Six (6) plant stands were randomly tagged per plot for collection of growth paramteres at 3, 5 and 7 weeks after planting (WAP) and yield attributes at harvest. Data collected were subjected to Analysis of Variance (ANOVA), and when significantly different, means of treatments were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability using ASSISTAT 7.1 statistical software.

RESULTS AND DISCUSSION

Pre-planting soil physio-chemical and Pig manure analysis

The pre-cropping physical and chemical characteristics of the soil shows that the soil is sandy clay loam in texture (sand 72.50%, silt 27.0% and clay 0.50%) and slightly acidic with pH 6.47. The soil is low in Organic Carbon (1.02%), Total N (0.08%), Available P ($3.42mgkg^1$), exchangeable bases Na (0.74cmol/kg), K (0.01cmol/kg), Ca (0.85cmol/kg) and Mg (1.26cmol/kg). The chemical analysis of pig manure analysis showed that it contains Organic Carbon (0.64%), Total N (0.6%) and Available P ($0.39mg/kg^{-1}$) and exchangeable bases. Na (0.02cmol/kg), K (0.06cmol/kg), Ca (0.2cmol/kg) and Mg (0.35cmol/kg). arrange the results in a table if possible

The inherent low fertility status of the soil is due to the continuous cropping of the soil without additional external inputs inform of fertilizer and is expected to benefits from the amendment with pig manure by improving the soil fertility status, reduced soil acidity and ultimately increased crop growth and yield.

Effects of different levels of pig manure on vegetative growth of cucumber

Results presented in Table 1 showed that that 25 t/ha^{-1} has the longest vine length (14.27cm) follow by 15 t/ha^{-1} (9.93cm), then 20 t/ha^{-1} (8.33cm), 10 t/ha^{-1}(7.27cm) control (6.50cm) with 5 t/ha^{-1} having the least (5.10cm) vine length respectively. Vine length of cucumber was significantly ($p<0.05$) affected by different levelsof pig manure at 3WAP and not significantly ($p<0.05$) affected at 5WAP and 7WAP.

Number of leaves was significantly ($p<0.05$) affected by different level of pig manure at 3 and 5 WAP with 25 t/ha^{-1} hadhaving the highest number of leaves (9.27 and 43.27) follow by 20 t/ha^{-1} (6.77 and 32.30), 15 t/ha^{-1} (7.27 and 28.47), 10

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t/ha^{-1} (6.60 and 26.63), control (6.03 and 19.93) and 5tonnes t/ha^{-1} having the least (5.23 and 16.30) number of leaves. At 7 WAP there were no significant difference ($p<0.05$) in the number of leaves produced by cucumber among treatments.

The results show that vine length increases as treatment increases except for 5 t/ha^{-} (3WAP, 5WAP and 7WAP) and 10 t/ha^{-1} (7WAP) having shorter vine lengths than the control plot, this might be due to the inherent soil fertility of the experimental location. This is in contrast to Sanni and Adenubi (2015) who reported that best growth characteristics of okra was found in soils amended with 5 t/ha^{-1} and also recorded that pig manure poorly influence the vine length of watermelon. The improved number of leaves due to manure application could be attributed to the mineralization of the manure. This is in line with the findings of Akanni (2005) that; manure application improves Organic matter, N, P, and Exchangeable Cation concentrations in the soil that could benefit grown crop.

The result in Figure 1 shows that different rates of pig manure had significant effects ($p< 0.05$) on number of days to 50% flowering. From the result cucumber planted on plots amended with 25 t/ha^{-1} flowered earlier than other treatment plots; closely followed by t/ha$^{-?1}$, 20 t/ha^{-1}, 10 t/ha^{-1}while 5 t/ha^{-1}and control plots flowered late. This was in accordance with Abd-Allah *et.al.,* 2001; Bayoumi, 2005; Ehaliotis *et.al.,* 2005, who reported that Fe, Zn and Mn encourages vegetative growth, total chlorophyll and the photosynthetic rate of plants which enhance early flowering and fruiting, leading to an increase early fruit maturity.

Effects of different levels of Pig manure on the Yield Attributes of Cucumber

Statistical analysis of the data indicated that number of harvested fruits, weight, width and its length were not significantly ($p<0.05$) affected by different rates of pig manure application (Figure 2). Treatment mean values showed that highest number of fruits were harvested from 25 t/ha^{-1} (7.65) closely followed by 20 t/ha^{-1} (5.67), 10 t/ha^{-1} (4.67), 15 t/ha^{-1} (3.33), 5 t/ha^{-1} (2.00) and control (2.00) having the least fruits respectively. Similar trend was observed for fruit length, weight and width respectively. The nutrients absorbed by the cucumber plants were effectively utilized in the formation of fruits, leaves and stem tissues. This is in agreement with Ibeawuchi *et. al.* (2007) who reported that dry matter accumulation affected the grain yield and 1000 maize relative yield.

The increased availability of nutrients in soil, due to application of the manures, expectedly led to increased uptake of N, P, K, Ca, and Mg. The findings that Organic manure significantly increase crop growth and yield is attributable to improve soil physio chemical properties. Better utilization of nutrients might also be the reason towards the increase in Cucumber yield obtained in this experiment. The higher yields obtained from plots with treatments may be due to their higher nutrient content particularly Fe, Zn and Mn in Compost (Akanbi, 2002).

Analysis Gross Margin analysis for Each Treatment

Table 2 shows the gross margin analysis of cultivation of cucumber using varying rates of pig manure. It is observed from the result that growing cucumber in the study area using 25 t/ha^{-1}has the highest gross margin (5345:00), while other treatments have gross margins less than 1:00 which makes production at the rates not profitable and running at a loss. This makes 25tonnes per hectare the most cost effective treatment for the production of cucumber in the study area.

CONCLUSION

The results obtained from this study clearly indicated that pig manure is a valuable source of crop nutrition which can improve soil biophysical and chemical

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conditions thereby making the soil more productive and sustainable for cucumber production. This organic manures is presently being wasted and constitute environmental nuisance, it can be converted to wealth by using them for the cultivation of organic crop production. Based on the outcome of the study, Pig manure at the rate of 25 t/ha^{-1} is the best for cucumber production and most profitable and cost effective in Ikorodu Local Government Area of Lagos State as it improved its growth and yield.

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Table 1. Effects of different levels of pig manure on cucumber growth.

	Vine length (WAP)			Number of leaves (WAP)		
Treatments	**3**	**5**	**7**	**3**	**5**	**7**
0 t/ha	6.50bc	46.30	118.32	6.03b	19.93bc	52.17
5 t/ha	5.10c	34.87	90.94	5.23b	16.30c	41.06
10 t/ha	7.27bc	52.53	117.59	6.60b	26.63bc	51.80
15 t/ha	9.93b	65.57	136.36	7.27ab	28.47bc	68.89
20 t/ha	8.33bc	65.97	142.18	6.77b	32.30ab	70.77
25 t/ha	14.27a	83.93	157.49	9.27a	43.27a	92.93

Means with similar letter(s) in the same column are not significantly different at 5% D.M.R.T. arrange the table.

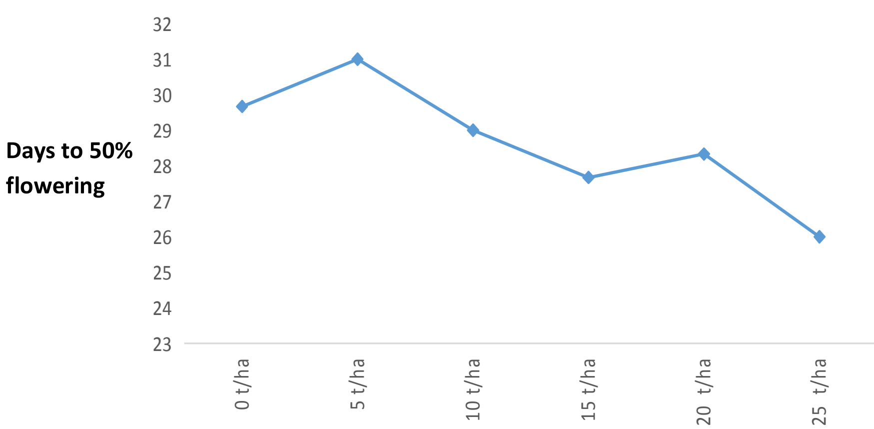

Figure 1. Effects of different levels of pig manure on the days to 50% flowering of cucumber plants.

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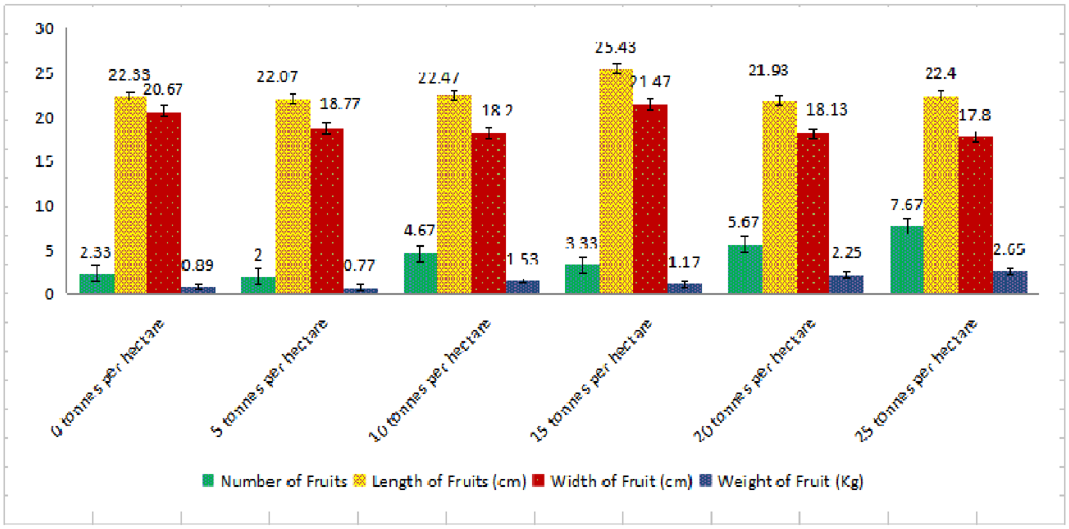

Figure 2. Effects of different levels of Pig manure on the Yield Attributes of Cucumber

Table 2. Analysis For Gross Margin Of Each Treatment

Treatment	Cost of production ( )	Yield(kg)	Price per kg ( )	Total revenue ( )	Gross margin ( )
0 t/ha	11900:00	18.9	100:00	1890:00	-10010:00
5 t/ha	11927:00	14.4	100:00	1440:00	-10487:00
10 t/ha	11954:00	65.8	100:00	6580:00	-5374:00
15 t/ha	11981:00	36.0	100:00	3600:00	-8381:00
20 t/ha	12008:00	113.9	100:00	11390:00	-618:00
25 t/ha	12035:00	173.8	100:00	17380:00	5345:00

Source: field survey 2018.

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Effects of Liquid and Solid Poultry Manure and Levels on Growth and Yield of Amaranth (*Amaranthus cruentus*).

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Abstract
Pot trial was conducted at the Department of Agronomy orchard, Faculty of Agriculture, Ahmadu Bello University, Zaria to evaluate 4 rates of solid poultry manure (0, 0.5, 1 and 2 t / ha) and 3 rates of liquid poultry manure (0, 0.5 and 1 t / ha) using Completely Randomized Design (CRD) with three repetitions. The objective of the study was to determine the effects of solid and liquid forms of poultry manure on amaranth production. Data were collected on plant height, leaf area, fresh and dry weight, which were statistically analyzed using 'F' test. The result reveled that, application of 2 t / ha of solid poultry manure increased amaranth plant height, leaf area, dry matter and fresh weight mainly when compared to the control. When liquid manure was applied the increments was notable only up to applied 0.5 t / ha on plant height, fresh and dry weight. This suggests that amaranth can be produce with the application of 2 and 0.5 t / ha of solid and liquid poultry manure respectively.
Key words: Solid and liquid poultry manure, amaranth, growth and yield.

INTRODUCTION

Amaranth (*Amaranthus cruentus*) is commonly used as leafy vegetables and is a cheap vegetable for the common man, which is highly rich in vitamins A and C in addition, it also provides protein, calcium, folic acid and phosphorus which are all essential nutrients as stated by nutritionists (Makus, 1990). Amaranth is eaten raw in salad and can also be prepared into several dishes.

In Nigeria, crop production is mostly practiced on subsistence scale and the bulk food producers are found among this group of farmers in the country. These farmers are poor resourced, thus, are faced with several constraints in the use of mineral fertilizers. Some of the constraints include escalated price of fertilizers, unavailability or late arrival of fertilizers, insufficient quantities of fertilizers, application of fertilizer below recommended rate, inappropriate correct usage, high cost and adulteration of fertilizers (Emuh *et al*., 2011). The same researchers observed that the negative

effects of the constrains on crop production is attaining optimum yield. The use of organic manure can be used to overcome these problems. Organic manure benefits both crop and environment in many ways; it helps to boost both nutrient efficiency and organic matter content in the soil, restore and maintain soil fertility to nurture plant growth, enhances biological activity and biodiversity of soils. It facilitates the slow release of nutrients (macro and micro) in response to the dynamic needs of plants, non-toxic to food and do not course environmental pollution unlike chemical fertilizer which contaminate both the land and water.

When it comes to manure there is none more desired for the vegetable garden than the chicken manure normally called poultry manure (Anonymous, 2012). Poultry manure is a useful source of nitrogen which is the main nutrient that plant need for green leafy growth, it also

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contains small amount of other important nutrients (Stephen *et al*.). These same group of researchers observed that poultry farming is gaining ground in Nigeria and vegetable growers are now frequently using poultry manure as a source of plant nutrition for vegetables production, but there are no evidence-based crop-wise recommendations on the optimum poultry manure application. However, the bottle neck of solid poultry manure is bulkiness, high transportation and application cost. The use of liquid manure is a new practice found among some farmers but its efficiency in research wise is yet to be determined. Liquid manure has benefits of reduced bulkiness and lower transportation and labour cost and it mode of application is friendly. Thus, there is the need to determine optimum solid and liquid manure level for Amaranth production.

MATERIALS AND METHODS

The trial was conducted at the Department of Agronomy Orchard (11° 11' N, 07° 37' E), Faculty of Agriculture, Ahmadu Bello University, Zaria during the rainy season of 2016. Treatments consisted of 4 rates of solid poultry manure (0, 0.5, 1 and 2 t / ha) and 3 rates of liquid poultry manure (0, 0.5 and 1 t / ha) laid out in completely randomized design (CRD) repeated three times. The soil was collected on 10th June, 2016 and mixed thoroughly before filling it in each pot. Poultry manure was incorporated on 14thJune, 2016 in to the pots as per treatments and allowed to decompose for 2 weeks. Amaranth was sown on 28th June, 2016 by drilling in the pot and covered lightly with soil. Thinning was done two weeks after germination living two stands per pot. The liquid manure was obtained by soaking the solid poultry manure in 50 ml of water for seven days and the extract was then applied as per treatments on 5th July, 2016. Weeds were controlled by hand pulling from each pot and weeds around pots were hand weeded. Amaranth was harvested manually by carefully uprooting the crop from the soil at 6 weeks after sowing.

Data collected include Plant height, Leaf area, fresh and dry weight per plant, these were statistically analyzed and treatment means were separated using Duncan's multiple range test (Duncan, 1955).

RESULTS

Table 1 showed physical and chemical properties of the excavated soil used to fill up the pots. The soil used for the experiment is sandy loam; it is moderate in organic carbon low total nitrogen, high cation exchange capacity and high available phosphorus.

Table 2 showed the response of plant height, leaf area, fresh and dry weight of amaranths to application of solid and liquid poultry manure. The result revealed that application of 2 t / ha of solid poultry manure resulted to taller plants than all other rates that had statistical similar at both sampled periods. But at 4 WAS, the control had shortest height which was also at per with applied 0.5 t / ha of solid poultry manure. Application of 0.5 t / ha of liquid poultry manure significantly produce taller plants than other rates that were at per at 4 WAS. This rate resulted to taller plants only when compared to the control at 6 WAS. Interaction between solid and liquid poultry manure on plant height was not significant at both sampled period.

The result showed that application of 2 t / ha of solid poultry manure resulted to larger leaf area at 4 and 6 WAS were other rates had statistically similar heights. At each sampling period, application of liquid poultry manure had no significant increment on plant height. There was no significant interaction between the factors.

Application of 2 t / ha of solid poultry manure statistically produce heavier fresh and dry weight than when compared to other applied rates that were at par. Application of 0.5 t / ha of liquid poultry manure produced heavier fresh and dry

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weight only when compared to the control. Interaction between solid and liquid poultry manure rates on dry matter and fresh weight was not significant.

DISCUSSION

The increment observed in height on pots applied with solid and liquid poultry manure could be attributed to nutrients contained in the manure thus, assisted in the vegetative growth of amaranth. Since poultry manure contain both macro and micro-nutrients it was able to meet up with the demand required by the crop as notice in the increased height of amaranth. Also, the low N and P (Table 1b) of the experimental soil used might have been aided with application of poultry manure thus supplying enough nutrients needed for the growth of the crop. The taller plants obtained at this level could have resulted to larger area covered by amaranth thus, increases light interception, and photosynthesis. These might be the reason for the larger leaf area obtained in the trial. The slow decomposition of organic manure might have also, supply the required nutrients in time frame for the crop. This conform to the findings of Okokoh and Bisong (2011) and Mshelia *et al*. (2013).

The increase in photosynthesis and assimilate production might have resulted to the heavier dm and fresh weight of amaranth. The positive effect of poultry manure on dry matter and fresh weight of the crop might be due to the balanced nutrient obtained in the organic manure which was utilized by the crop. Also, the low fertility status of the soil might have been build up with application of manure thus increasing the nutrients in the pots and resulted to higher dm and weight. These confirm with the findings of Msibi *et al.,* 2014 who worked on manure application on amaranth.

CONCLUSION

Based on the study it can be suggested that for amaranth production farmers can apply 2.0 and 0.5 t / ha of solid and liquid poultry manure.

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Table 1a: Shows the chemical properties of poultry manure used for the study.

Poultry manure	Result (%)
Nitrogen	2.10
Phosphorus	1.30
Potassium	0.603

Poultry manure analyzed at agronomy department IAR/ABU Zaria.

Table 1b: Physical and Chemical properties of the soil of the experiment during the 2016 raining Season.

Soil composition	0-30cm
Particle size distribution (g / kg)	
Clay	160
Sand	200
Silt	640
Textural class USDA	Sandy loam
Chemical composition	
pH(H_2O)	6.60
pH($CaCl_2$)	5.60
Organic Carbon (g / kg)	0.650
Total Nitrogen (g / kg)	0.315
Available Phosphorus (mg / kg)	23.28
Exchangeable bases (Cmol / kg)	
Ca	3.06
K	0.43
Mg	0.33
Na	0.27
H + Al	0.40
C.E.C	5.9

Soil samples analyzed at soil science department IAR/ABU, Zaria.

Table 2: Effects of solid and liquid poultry manure rates on amaranth plant height, leaf area, dry matter and fresh weight at harvest during the 2016 raining season.

	Plant height (cm) (WAS)		**Leaf area (cm) (WAS)**		**Dry matter (g/ plant)**	**Fresh weight (g/ plant)**
Treatments	**4**	**6**	**4**	**6**	**At harvest**	**At harvest**
Solid poultry manure t / ha						
0	10.87c	14.03b	20.00b	33.09b	146.56b	27.85b
0.5	13.34bc	16.71b	23.75b	36.75b	188.83b	35.88b
1.0	15.34b	18.07b	31.98b	61.27ab	207.51b	39.43b
2.0	19.28a	24.11a	68.99a	131.91a	344.12a	65.38a
SE±	0.976	1.612	12.180	27.697	33.333	6.333
Liquid poultry (t / ha)						
0	13.15b	16.38b	26.64	51.00	185.18b	35.19b
0.5	17.12a	20.86a	33.41	52.36	280.15a	53.23a
1.0	13.85b	17.44ab	48.50	93.90	199.93ab	37.99ab
SE $\pm$	0.845	1.396	10.549	23.986		5.485
Interactions						
S x L	NS	NS	**	**	NS	NS

Mean followed by the same letter(s) in the same column within the same treatment group are statistically similar (P>0.05) using Duncan Multiple Range Test (DMRT). NS = Not significant.

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Experiment on the Effects of Different Soil Textural Types on the Growth of Two Varieties of *Solanum* spp.

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Abstract
Experiment on the effects of different soil textural types on the growth of two varieties of solanumsppwas carried out using different types of soil (sandy soil s[1], clayey soil[2] and loamy soil s[3]). In the premises of crop science department, Imo State University Owerri, 2018. The seeds of two varieties of eggplant (solanumgilo and solanummelongena) were sourced from the seed bank of National Horticultural research institute (NIHORT) MbatoOkigwe, Imo State Nigeria. The experiment is a 3x2 factorial experiment in Completely Randomized Design (CRD) with three replications. Factor A (soil types) which are clayey, sandy and loamy soil, while factor B (eggplant varieties) which are solanummelogena and solanumgilo. In all eighteen experimental units (poly bags) were used for this experiment.Data were analyzed using ANOVA, GenStat® Version 12 (VSN International, UK). Means were separated using Least Significant Difference (LSD) procedure at the 5% level of significance.Result shows that the mean values of plant height of solanummelogena and solanumgilo at 4, 6 and 10 weeks after transplanting (WAT) as influenced by soil types. At 4 WAT, solanummelogena and solanumgilo planted to loamy soil recorded the highest mean values of plant height; 11.47cm and 10.17cm respectively. Result also indicated that plant height at 4 WAT showed significant differences ($P < 0.05$) existed between soil types and solanummelogena, solanumgilo, but Interaction between the two factors were non-significant ($p>0.05$). Solanummelogena planted to loamy soil had the highest (18.76cm) plant height at 10 WAT. However, this result did not significantly differ ($p> 0.05$) from 18.00 cm recorded as plant height of solanumgilo at 10 WAT.
Keyword: Soil textural types, Solanum melogena, Solanum gilo

INTRODUCTION

Fruits and vegetables are very important rich source of essential vitamins, minerals, and dietary fiber and plant proteins in human diets throughout the world (Alam*et al.,* 2003; FAO 1995). Fruits and vegetable cultivation is one of the most dynamic and major branches of agriculture known as horticulture, and from the point of view of economic value of the produce, they are most valuable and nutritious food commodities which can substantially contribute to improve the social welfare and health status of the rural as well as urban populations (El Shafie, 2001). Eggplant (*Solanumgilo*) is a typical vegetable of which its cultivation helps improve human nutrition and generate income (Alam*et al.,* 2003). Egg Plant (*Solanumgilo*) is in the family Solanaceae and of the Order– Sonales. Eggplant is identified with many names in various ethnic groups in Nigeria. For Example it is called Yalo in the northern part of Nigeria, Ańara in the easthern part of Nigeria, and the Yoruba call it Igba. It is also known as Aubergine, Brinjal, Birigiyan or Guinea Squash in some parts of the world.

The name Eggplant is derived from the shape of the fruit of some varieties which are white and resemble the shape of chicken egg. It is a popular vegetable crops grown round the year in most countries. It holds an important place in China, India, Japan and most African countries (Pugalendhi*et al.,* 2010). Eggplant is a delicate perennial but often grown commercially as an annual crop. The flowers are white to purple with a five lobed corolla and yellow stamens. The fruits are fleshy, have a meaty texture and are less than 3cm (1.2in) in diameter. The fruit is botanically classified as a berry and contains numerous small soft seeds which are edible, but has a pleasantly bitter taste because of the presence of nicotinoid alkaloids (Pugalendhi*et al.,* 2010).

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Eggplant is propagated by seeds; the seeds are sown in a well prepared raised seed beds with friable soil. The optimum temperatures for eggplant are in the range of 25℃ and 35℃ and the night temperature 20-27℃. It is tolerant to drought and excessive rainfall and does best in well drained, sandy loam soils. The best environmental conditions are normally found in low land areas with relative little temperature variation. The pH requirement ranges from 6-7 with the optimum being pH 6.0 (Talekar, 2003). Eggplant is a popular African fruit which remains a delight for researchers as its effects are not only nutritional but significant of health benefits (Wole, 2011). Studies revealed that eggplant positively help with heart problem and help in weight reduction diet (Wole, 2011). The fruit is low in calories and fats, due to its low calorie (24kcal/100g) and high potassium content (200mg/100g) it is suitable for diabetic, hypertensive and obsessed patients (Prabhu*et al.,* 2009; Pugalendhi*et al.,* 2010; Daniela *et al*., 2007). It is a good source of mineral and vitamins (FAO, 1995), and also rich in total water soluble sugars, free reducing sugars, amide protein among other nutrients (Goplan*et al.,* 2007). It has also been recommended as an excellent remedy for those suffering from liver disorder (Shukilar and Nalk, 1993).

In some studies conducted in Africa, it was found that eggplant is very effective in blood cholesterol reduction, protection from poor vision due to glaucoma (Igwe*et al.,* 2011). It contains necessary salt that helps in maintaining the functions of the heart and regulates blood pressure (Wole, 2011). The study done by Anosike*et al.,* (2011) proved that garden egg could be used for the treatment of stomach ulcer because it possesses ulcer protective properties.

The need to determine the most suitable soil type for the production of this important fruit necessitated the desire for this trial. Hence the need determine the best soil textural type for the production of Solanummelongena and Solanumgilo; and also determine the yield of Solanummelongena and Solanumgilo under different soil textural types.

MATERIALS AND METHODS

This experiment was carried out at the premises of Crop Science Department, Imo State University, Owerri. The area is located within Latitude 5.485° N and Longitude 7.035° E. The average temperature is 26.4℃ (Climate-Data.org).

The seeds of two varieties of Eggplant, *Solanumspp* (*Solanumgilo*and *Solanummelogena*) were sourced from the seed bank of National Horticultural Research Institute (NIHORT) MbatoOkigwe, Imo state, Nigeria. The seeds were used for this experiment. *Solanumgilo* and *Solanummelogena seeds* were nursed in the nursery on prepared nursery bed of 2m x 2m size each respectively. The Eggplant seedlings were sown in rows, lightly covered with sand and mulch. The beds were watered regularly and maintained weed free. Matured seedlings attaining height of 10 – 15 cm and having about 4 - 5 true leaves (Tindal, 2005) were transplanted to the experimental units (pots) at four (4) weeks after sowing.

The experiment is a 3 x 2 factorial experiment in Completely Randomized Design (CRD) with three (3) replications. Factor A (Soil textural types) which are clayey, sandy and loamy soils while factor B (Eggplant varieties) which are *Solanummelogena*and*Solanumgilo.* In all, eighteen experimental units (poly bags) were used for this study.

Experimental treatments were three soil types; Sandy loam, loamy and clayey loam soils and two varieties of Eggplant; *Solanumgilo*and *Solanummelogena*. The soil textural types were sourced by a soil scientist and analysed to ascertain their physiochemical properties while the

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eggplant varieties was sourced from the gene bank of National Horticultural Research Institute, MbatoOkigwe, Imo State.

RESULTS

The results of the experiment were presented in tables below:

DISCUSSION

Plant height of *Solanummelogena*and *Solanumgilo* were significantly increased in loamy soil compared to sandy and clayey soils. Previous investigation by Brown, (2007) reported that loamy soils contain more nutrients, moisture, and humus than sandy soils, and that it has better drainage and infiltration of water and air than clayey soils. This report, however, could explain the reason for this increased plant height obtained from eggplants planted to loamy soil.Brown, (2007) also reported that loamy soil is suitable for growing most plant varieties. His assertion is partially validated by the results of this current study which revealed that eggplant varieties planted to loamy soil had more number of leaves per plant per pot than sandy and clayey soils. The increase in the number of leaves of *Solanummelogena*and *Solanumgilo* in pots containing clayey soils indicated that loamy soil was able to release more nutrients for the vegetative growth of the eggplants. This result is in agreement with the earlier findings of John *et al.* (2004) that loamy soils contains more essential nutrients associated with high photosynthetic activities and thus promotes root and vegetative growth.

Loamy soil is considered ideal for gardening and agricultural uses because it retains nutrients well and retains water while still allowing excess water to drain away. This is evident in the profuse branching of eggplants planted to loamy soil used in this experiment. *Solanummelogena*and *Solanumgilo* planted to loamy soil recorded significantly more branches than sandy and clayey soils.In terms of plant girth, eggplant varieties planted to loamy soil had wider girth than those planted to other soil types. Similar result was recorded by Uwalaka, (2015) who worked on five varieties of eggplant. The result of this present study further corroborates the findings of Aliyu, (2010) who stated that loamy soil have greater proportion of organic matter content than sandy and clayey soils. This affirmation may account for the vigorous girth recorded from eggplant varieties planted to loamy soil. Fruit number and yield were highest with *Solanummelogena*and *Solanumgilo* planted to loamy soil. This result further suggests that loamy soil as had been reported is suitable for growing eggplant for good growth and yield.

CONCLUSION AND RECOMMENDATIONS

The results obtained from the study showed that *Solanummelogena*and *Solanumgilo* grown in sandy, clayey and loamy soils. Growth parameters of eggplant such as plant height, number of leaves, number of branches and plant girth assessed at 4, 6, 8 and 10 WAT performed better in loamy soil than in sandy or clayey soils.Moreso, *Solanummelogena*and *Solanumgilo* planted to loamy soil produced highest number of fruits and corresponding higher fruit yield.

Further studies should be conducted to validate the results of this study. Eggplant farmers should grow their eggplants in loamy soils.

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Table 1: Plant height (cm) of *Solanum melogena* and *Solanum gilo* as influenced by different soil types

	Eggplant variety											
	4 WAT			6 WAT			8 WAT			10 WAT		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	8.63	9.65	9.14	10.20	9.60	9.90	12.87	11.53	12.20	14.80	13.75	14.28
S_2	10.13	10.13	10.13	10.53	11.60	11.07	13.57	13.73	13.65	15.00	16.07	15.54
S_3	11.47	10.17	10.32	12.33	12.23	12.28	16.10	16.00	16.05	18.76	18.00	18.38
Mean	9.74	9.89		11.02	11.14		14.18	13.76		16.19	15.94	
LSD0.05 (Soil type):		1.96			0.67			2.09			2.59	
LSD0.05 (Eggplant variety):		1.60			0.54			1.71			2.11	
LSD0.05 (Interaction):		Ns			0.94			2.96			3.66	

S_1 - Sandy soil
S_2 - Clayey soil
S_3 - Loamy soil
E_1 - *Solanummelogena*
E_2 - *Solanumgilo*
WAT - Week After Transplanting
Ns - Not Significant

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Table 2: Effect of different soiltypes on number of leaves per plant per pot of *S. melogena*and *S. gilo.*

	Eggplant variety											
	4 WAT			6 WAT			8 WAT			10 WAT		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	3.10	3.23	3.17	4.50	4.37	4.62	7.00	7.33	7.17	11.67	11.70	11.69
S_2	3.57	3.77	3.67	5.00	5.43	5.22	8.00	8.33	8.17	12.00	12.17	12.09
S_3	4.20	3.84	4.02	5.87	5.53	5.70	8.67	8.33	8.50	13.10	12.07	12.59
Mean	3.62	3.61		5.12	5.23		7.89	8.00		12.26	11.98	
LSD0.05 (Soil type):		Ns			0.76			0.87			1.39	
LSD0.05 (Eggplant variety):		Ns			0.62			0.71			1.14	
LSD0.05 (Interaction):		Ns			1.07			1.23			1.97	

S_1 - Sandy soil
S_2 - Clayey soil
S_3 - Loamy soil
E_1 - *Solanummelogena*
E_2 - *Solanumgilo*
WAT - Week After Transplanting
Ns - Not Significant

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Table 3: Number of branches of *S. melogena* and *S. gilo* as influenced by sandy, clayey and loamy soils

	Eggplant variety											
	4 WAT			6 WAT			8 WAT			10 WAT		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	1.67	1.85	1.76	2.55	2.50	2.53	3.40	3.47	3.44	4.80	4.63	4.72
S_2	1.90	1.97	1.94	2.67	2.79	2.73	3.67	3.47	3.57	5.10	4.63	4.87
S_3	2.10	1.97	2.04	3.10	2.83	2.97	4.07	3.50	3.79	5.40	4.90	5.15
Mean	1.89	1.93		2.77	2.71		3.71	3.48		5.10	4.80	

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Table 4: Plant girth (cm) of *S. melogena*and *S. gilo*as affected by sandy, clayey and loamy soils

	Eggplant variety											
	4 WAT			6 WAT			8 WAT			10 WAT		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean	E_1	E_2	Mean
S_1	1.40	1.40	1.40	2.10	1.97	2.04	3.20	2.28	2.74	3.77	3.60	3.69
S_2	1.53	1.47	1.50	2.27	2.20	2.24	3.30	2.80	3.05	4.20	3.87	4.04
S_3	2.03	1.60	1.82	2.57	2.43	2.50	3.58	3.30	3.44	4.63	4.30	4.47
Mean	1.66	1.49		2.31	2.20		3.36	2.79		4.20	3.92	
LSD0.05 (Soil type):		0.57			0.70			0.30			0.98	
LSD0.05 (Eggplant variety):		0.46			0.57			0.14			0.80	
LSD0.05 (Interaction):		0.80			0.99			1.27			1.39	

S_1 - Sandy soil,S_2 - Clayey soil,S_3 - Loamy soil, E_1- *Solanum melogena,* E_2 - *Solanum gilo*
WAT - Week After Transplanting, Ns - Not Significant, S_1 - Sandy soil, S_2 - Clayey soil

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Table 5: Number of fruit per plant and fruit yield (kg/plant/pot) of *S. melogena*and *S. gilo* as influenced by different soil types

	Eggplant variety					
	Number of fruits			Fruit yield (Kg)		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean
S_1	7.50	6.00	6.75	1.03	1.00	1.02
S_2	9.88	8.78	9.33	1.45	1.20	1.33
S_3	15.66	14.73	15.20	2.38	2.16	2.27
Mean	11.01	9.84		1.62	2.18	
LSD0.05 (Soil type):		4.05			0.69	
LSD0.05 (Eggplant variety):		4.23			0.88	
LSD0.05 (Interaction):		5.08			0.92	

	Eggplant variety					
	Number of fruits			Fruit yield (Kg)		
Soil type	E_1	E_2	Mean	E_1	E_2	Mean
S_1	7.50	6.00	6.75	1.03	1.00	1.02
S_2	9.88	8.78	9.33	1.45	1.20	1.33
S_3	15.66	14.73	15.20	2.38	2.16	2.27
Mean	11.01	9.84		1.62	2.18	
LSD0.05 (Soil type):		4.05			0.69	
LSD0.05 (Eggplant variety):		4.23			0.88	
LSD0.05 (Interaction):		5.08			0.92	

S_3-Loamy soil,
E_1-*Solanum melogena,*
E_2-*Solanum gilo,*
WAT -Week After Transplanting
Ns-Not Significant

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Influence of Seedbed Preparation Methods on Seedling Emergence, Growth and Yield of Sesame in an Ultisol, Kogi State, Nigeria.

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Abstract

This study was carried out at the Teaching and Research Farm of the Agronomy Session, Kabba College of Agriculture in 2015, and repeated in 2016 to investigate the effect of seedbed preparation methods on seedling emergence, growth and yield of sesame in an Ultisol. The treatments consisted of four seed bed preparation methods (plough alone, plough plus harrow, plough plus double harrow, and plough plus harrow plus ridge) the experiments was arranged in a randomized complete block design.Data were collected from ten randomly selected plants in each plot. Data were taken on agronomic traits such ason establishment count, plant height, number of leaves per plant, number of branches, stem girth, leave area, panicle length, panicle weight, number of seeds per pod and number of seeds per plant. All the data were subjected to analysis of variance (ANOVA) to determine the significance of variations among the treatments and means were separated using Least Significance Difference (LSD) test at 5% level of probability. The result revealed that plots with plough + double harrow were significantly better in percentage seedling emergence than other plots. Plots with 3 operations (plough + double harrow and plots with plough + harrow + ridge) were significantly better in growth characters than plots with 2 operations (either plough alone or plots with plough + harrow). Also, plots with plough + double harrow and plots plough + harrow + ridge were significantly better in capsules characters than plots with plough alone or plough + harrow once. Plots with plough + double harrow and plough + harrow + ridge were significantly better in seed yields per plot and seed yield per land area than plots with either plough Alone or plough + harrow once. However, Lodging percentage was highest in plots with plough + harrow + ridge compared to plots with either plough Alone, plough + harrow once and ploughs + double harrowand thus plough + double harrow is suggested as methods of seedbed preparation for sesame in the study area and related ecologies.

***Keywords**: Sesame, Seedbed, Emergence, Capsule, Growth, Yield*

INTRODUCTION

Sesame (*Sesamum indicum* L.) is widely grown in tropical regions of Africa for edible seeds, oil and for livestock feed. Sesame has50% - 60% ofoil content (Toan*et al*., 2010). Its seeds and young leaves are eaten as stews and soups (Pakisson.com, 2010). The oil-cake is good feed for poultry, goat, sheep, fish and cattle (Khan, 2009).Unfortunately, growth and yield of the crop are generally low because the crop is considered as a minor crop (Haruna and Usman, 2005).

Seed bed preparation is considered one of the factors for increasing the yield of sesame per unit area. According to (Lal, 1986), the primary aims of good seedbed preparation are: to control weeds, manage surface trash, provide aeration, shape or level the soil, improve physical conditions of the soil, incorporate fertilizers, break hard pans and allow better water and air infiltration. Frequent use of tractor mounting the tillage implements often lead to soil compaction, that is, increase of the natural density of soil at a particular depth (Quin *et al*, 2006). The density increase translates into less pore space, less water availability to plants, slower water transport and decreased roots penetration into the soil as it seeks out water and nutrients(Singh and Malhi, 2006). Similarly, bulk density increase due to compaction can serve to retard or divert

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the flow of water, resulting in pond formation or excessive runoff. Soil moisture is the source of water for plant use (Mweso, 2003). Soil moisture is highly critical in ensuring good and uniform seed germination and seedling emergence (Arsyid, 2009), crop growth and yield.

In Nigeria, sesame production is low due to poor farmers' access to improved varieties, appropriate agronomic practices, and low soil productivity. Presently studies on sesame agronomic practices in Nigeria are mostly on plant population, fertilizer rate, and row spacing mostly in the northern Guinea savanna zone (Malik *et al*., 2003). However, research on effect of different land preparation methods has been scanty particularly in the Southern Guinea Savanna zone. It was necessary to conduct this study with the objective of determining the influence of seedbed preparation methods on seedling emergence, growth and yield of sesame in an ultisol.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research farm of the Agronomy Session, Kabba College of Agriculture in 2015, and repeated in 2016.The site is located at latitude of 07° 35' N and longitude of 06° 08' E and is 435 m above the sea level, in Southern Guinea Savanna Agro Ecological Zone of Nigeria. The rainfall spans between April and November with its peak in June. The dry season extends from December to March. The mean annual rainfall is 1350mm per annum with an annual temperature range of 18°C - 32°C. The mean relative humidity (RH) is 60% (Meterological data, 2015). The major soil order within the experimental site is Ultisol (Babalola, 2010).

The treatments consisted of four seed bed preparation methods (plough alone, plough plus harrow, plough plus double harrow, and plough plus harrow plus ridge) arranged in and laid out in a randomized complete block design with three replications. Four seeds of sesame were planted per hole at a depth of about 1 cm and later thinned down to one plant per stand two weeks after germination. SSP and MOP fertilizer at the rate of 100 kg SSP ha-1 and 60 kg MOP ha-1 were applied as a blanket treatment to all the plots, using broadcasting method two weeks after germination.

Data were collected from ten randomly selected plants in each plot. Data were taken on the basis of agronomic traits such ason establishment count, plant height, number of leaves per plant, number of branches, stem girth, leave area, panicle length, panicle weight, number of seed per pod and number of seeds per plant.

All the data were subjected to analysis of variance (ANOVA) to determine the significance of variation among the treatments and means were separated using Least Significance Difference (LSD) test at 5% level of probability (Carmer and Swanson, 1973).

RESULTS

Table 1 shows the physicochemical properties of the soil before planting. The percentage (%) sand, silt and clay of the soil were 64.5, 20.0 and 15.5 respectively; indicating the soil to be of sand clay loam with the pH of 6.2. The nitrogen content of the soil was 0.14%, the available phosphorus content of the soil was 10-12 mg/kg and the exchangeable potassium content of 0.46 (cmol/kg). The Ca, Mg and organic matter contents available in the soil were2.50, 2.54 (cmol/kg) and 2.14% respectively.

Table 2 presents the results of effect of seedbed preparation methods on days to 50% seedling emergence and percentage seedling stands at 60 days after planting. The result shows that days to 50% seedling emergence was not significantly affected by seedbed preparation methods. However, percentage seedling stands at 60

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days after planting was significantly affected.

Plots with plough + double harrow produced highest percentage of seedling emergence and this was significantly better than plots with plough alone, plough + harrow and plough + harrow + ridge. Percentage seedling emergence was lowest in plots with plough alone.

Growth characters of sesame as influenced by seedbed preparation methods are presented in Table 3. Seedbed preparation method significantly affects plant height, number of leaves and branches in sesame. Plots with plough + harrow + ridge were better in plant height, number of leaves and branches produced. However this was not significantly better than plots with plough + harrow + ridge. Plots with plough alone had the least plant height, number of leaves and branches in this experiment.

Table 4 presents the result of effect of seedbed preparation methods on days to 50% flowering and podding in sesame. The effect of seedbed preparation method was not significant on days to 50% flowering and podding in this experiment.

The effects of seedbed preparation methods on capsules character of sesame are presented in Table 5. The result shows that number of capsules per plant, individual capsule weight, weight of capsules per plant and numbers of seeds per capsule were significantly affected by seedbed preparation methods.

Seedbed preparation method significantly affects number of capsule per plant, individual capsule weight, weight of capsules per plant and number of seeds per capsule. Plots with plough + double harrow had the highest number of capsule per plant, individual capsule weight, weight of capsules per plant and numbers of seed per capsule. Though, all these were not significantly better than plots treated with plough + harrow + ridge but significantly better than plots treated with plough alone and plough + harrow. The least values of number of capsule per plant, individual capsule weight, weight of capsules per plant and number of seeds per capsule were recorded in plots with plough alone.

Both seed yield per plot and seed yield in tons per hectare were significantly affected by different land preparation methods used. Plots with plough + double harrow had the greatest yield either in seed yields per plot or per hectare. This was closely followed by plots with plough + harrow + ridge (Table 6). However, these were similar and significantly better than plots with plough alone or plough + harrow. The lowest seed yield per plot and seed yield per hectare were recorded in plots with plough alone (Table 6). Effects of seedbed preparation on percentage lodging of sesame plants are presented in Table 7. The results shows that percentage lodged was highest in plots with plough + harrow + ridge and this was significantly inferior to plots with plough + double harrow, plough + harrow and plough alone. The least lodging percentage was observed in plots with plough + double harrow.

DISCUSSION

The inherent poor nutrient status of the experimental site is a reflection of savannah soils. The low nutrients status at the experimental site agreed with the reported work of Shiyan and Binang, 2013) on tropical soils. This inherent low nutrient could be due to plant nutrient uptake as a result of continuous farming. ECA, (2001), reported that the zone is characterized with continuous cultivation which leads to rapid decline of soil nutrients and unstable microbial population

The result revealed that effect of seedbed preparation methods had no significant effect on days to 50% seedling emergence. This indicated that seeds required similar days for emergence. The non significant difference in days to 50% emergence was

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due to a good germination condition enjoyed by the seedlings due to regular rainfall at the time of planting. This result was in agreement with the work of Mayer and Polijakoff-Mayber (1992). They reported germinations of sesame seed is influenced by moisture and temperature.

Plots with plough + harrow twice were significantly better in number of sesame survive at 60 days after planting than either plot treated with plough alone, plough + harrow and plough + harrow + ridge. Soil pulverization was better when soil undergo double harrow, this could be responsible for better survival of the seedlings in plots with plough + double harrow. Germination was lower in plots with plough + harrow + ridge than plots with plough + double harrow. Seed of sesame are small and could be affected by reel erosion that could occur when water flows from the top of the ridge to the furrow water. This could be responsible for low seedling emergence in plots with plough + harrow + ridge.

Plots with plough + double harrow and plots with plough + harrow + ridge were significantly better in growth characters than plots with plough alone and plot with plough + harrow. Boguzas*et al*. (2010) reported that good seedbed preparation created favourable conditions for plant growth in loose soils with a proper air to water ratio, sufficient amount of organic matter and high microbiological activity. The better growth characters observed in plough + harrow + ridge and plough + double harrow plots could be probably attributed to good soil physical conditions created when the soil is properly tilled.

Plots with plough + double harrow and plots with plough + harrow + ridge were significantly better in capsules characters than plots with plough alone or plough + harrow once. Good seed beds help to improve soil physical properties which in turn improve the performance of crops in terms of growth and yield. This may account for higher capsules characters observed in plots with plough + double harrow or plough + harrow + ridge. The result was in agreement with findings of Babatunde *et al*. (2016). They reported highest yield characters of maize in plots with plough + harrow + ridge.

Lodging percentage was highest in plots with plough + harrow + ridge compared to plots with either plough alone, plough + harrow once and plough + double harrow this happened because the crops are planted on raised platform, where little wind action could possibly cause a severe damage to the crops.

CONCLUSION

From the findings of this work, it can be concluded that plots with either plough+ harrow + ridge or plough + double harrow were significantly better in growth and seed yields than plots with either plough Alone or plough + harrow once. However, lodging of sesame was highest in plots with plough + harrow + ridge compared to plots with plough + double harrow and thus plough + double harrow is suggested as methods of seedbed preparation for sesame in the study area and related ecologies, but further research should be carried out in different ecologies to confirm the results obtained in this study.

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Table 1: Condition of the soil before the experiment

Properties	*Values*
Sand (%)	64.5
Clay (%)	20.0
Silt (%)	15.5
Soil texture	Sandy clay loam
Soil Ph	6.2
Bulk density (g/cm^3)	1.41
Total porosity (%)	42.5
Organic matter (%)	2.14
Total N (%)	0.16
Available P (mg/kg)	2.72
Exchangeable cation (cmol/kg)	
K	0.46
Ca	2.5
Mg	2.54

Table 2: Effect of seedbed preparation methods on seedling emergence and percentage number of seedlings at 60 days after sowing

Seedbed preparation method	*Days to50%Seedling emergence*			*Seedling stands at 60 days after planting (%)*		
	2015	2016	mean	2015	2016	mean
PA	4.06	4.26	4.16	64.3	71.3	67.8
P+H	4.11	4.29	4.20	68.4	72.8	70.6
P+H+H	4.24	4.22	4.23	96.1	92.1	94.1
P+H+R	4.10	4.26	4.18	74.3	63.9	69.1
LSD	Ns	Ns	ns	13.4	17.8	19.62

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

Table 3 Effect of seedbed preparation methods on growth characters of sesame

Seedbed preparation method	*Plant height cm*			*Number of leaves*			*Stem girth cm*			*Number of branches*		
	2015	2016	mean	2015	2016	mean	2015	2016	mean	2015	2016	mean
PA	4.06	4.26	4.16	64.3	71.3	67.8	2.31	2.27	2.29	6.89	8.03	7.46
P+H	4.11	4.29	4.20	68.4	72.8	70.6	2.00	2.64	2.32	9.02	8.96	8.99
P+H+H	4.24	4.22	4.23	96.1	92.1	94.1	2.41	2.25	2.33	9.19	9.09	9.14
P+H+R	4.10	4.26	4.18	74.3	63.9	69.1	2.48	2.26	2.37	9.88	10.52	10.2
LSD	ns	ns	ns	13.4	17.8	19.62	ns	ns	ns	1.11	1.21	1.60

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

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Table 4: Effect of seedbed preparation on days to 50% flowering and podding

Seedbed preparation method	*Days to 50% flowering in sesame*			*Days to 50% flowering in sesame*		
	2015	2016	mean	2015	2016	Mean
PA	52.78	51.48	52.13	89.14	89.08	89.11
P+H	53.33	51.13	52.23	89.96	88.86	89.41
P+H+H	52.54	51.80	52.17	89.79	88.95	89.37
P+H+R	51.58	52.56	52.07	88.00	90.56	89.28
LSD	Ns	Ns	ns	ns	ns	Ns

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

Table 5: Effect of seedbed preparation methods on capsules characters

Seedbed preparation method	*Number of capsules/plant*			*Individual capsule weight (g)*			*Number of capsules/plant*			*Individual capsule weight (g)*		
	2015	2016	mean	2015	2016	mean	2015	2016	mean	2015	2016	mean
PA	125.6	140.6	133.1	1.75	1.21	1.48	0.23	0.17	0.20	445.8	731.0	588.4
P+H	149.1	156.1	152.6	1.99	0.87	1.43	0.24	0.26	0.25	568.4	636.8	602.6
P+H+H	206.4	190.4	198.4	2.14	2.04	2.09	0.48	0.34	0.41	989.2	1012.6	1000.9
P+H+R	196.3	182.9	189.6	2.00	1.94	1.97	0.41	0.33	0.37	983.9	1002.9	993.4
LSD	41.1	6.8	17.2	0.15	0.24	0.11	0.08	0.02	0.04	16.4	18.1	12.9

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

Table 6: Effect of seedbed preparation methods on seed yield per hectare in sesame

Seedbed preparation method	*1000 seed weight (g)*			*Seed weight/ plot (kg)*			*Seed yield/ hectare (t/ha)*		
	2015	2016	Mean	2015	2016	mean	2015	2016	Mean
PA	21.56	19.56	20.61	0.53	0.41	0.47	0.66	0.51	0.59
P+H	19.41	22.51	20.96	0.68	0.50	0.59	0.85	0.63	0.73
P+H+H	22.17	19.52	21.13	1.21	1.05	1.13	1.52	1.31	1.41
P+H+R	22.74	21.30	22.02	0.99	1.03	1.01	1.24	1.29	1.26
LSD	Ns	ns	Ns	0.11	0.14	0.17	0.32	0.26	0.29

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

Table 7: Effect of seedbed preparation on percentage of seedlings lodged due to wind

Seedbed preparation methods	*Percentage of seedlings lodged due to wind*
PA	55
P+H	61
P+H+H	42
P+H+R	78
LSD	19.46

Legend: PA= Plough alone, P + H = Plough plus Harrow, P + H + H =Plough plus Double Harrow, P + H + R = Plough plus Harrow plus Ridge.

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Growth and Yield of Garden Cress (*Lepidium sativum* L.) as Influenced by Sowing Methods and Poultry Manure at Samaru in the Northern Guinea Savanna Ecological Zone of Nigeria.

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Abstract
A field experiment was conducted during the of 2017 wet season at the Horticultural Garden of the Institute for Agricultural Research, Ahmadu Bello University, Samaru-Zaria to study the growth and yield of garden cress (Lepidium sativum L.)as influenced by sowing methods and poultry manure. The treatments consisted of two sowing methods (broadcasting and drilling) and four poultry manure rates (0, 1.5, 3, and 4.5 t ha^{-1}).The experiment was laid out in a factorial trial and laid out in a randomized complete block design (RCBD) replicated three times. The results showed that sowing methods hadnon- significant ($P \geq 0.05$) effects on the growth and yield of garden cress, however, significant ($P \leq 0.05$) responses were observed with the varied poultry manure rates. Taller plants were observed with the addition of poultry manure in comparison with the control at 5 weeks after sowing (WAS).Similar trend was observed with shoot dry matter at 5 WAS, fresh yield at harvest, and seed yield. Significant interactions between sowing method and poultry manure on the fresh weight and seed yield of the crop were observed. The control (non application of poultry manure) gave significantly lower fresh yield and seed yield than the other rates with both sowing methods while the combination of 4.5 t ha^{-1} and drilling significantly produced the highest fresh yield and seed yield, respectively. Regression analysis showed that seed yield linearly regressed with poultry manure.Therefore, based on the results obtained, it can be concluded that the combination of drilling method of sowing and application of 4.5 t ha^{-1} of poultry manure produced the highest yield of garden cress at Samaru.

Keywords: *Garden Cress, Broadcasting, Drilling, Poultry manure,*

INTRODUCTION

Garden cress (*Lepidium sativum* L.) is a fast growing edible plant with a peppery tangy aroma. It is an annual, erect, herbaceous plant which belongs to the Brassicaceae family (Diwakar *et al.*, 2010). The crop is believed to have originated primarily in the highland region of Ethiopia and Eritrea (Diwakar *et al.*, 2010.). In Nigeria it is locally known as Diwakar *et al.*, 2010Diwakar *et al.*, 2010Lamsir." in Hausa language. Garden cress grows best in cultivated areas that receive full sunlight . It is well suited to many soil types and climate as long as the soils are moist and have nutrients, although, it does not tolerate frosts. The crop has low fertility requirement due to its short growing time and thrives well within the pH level of 6.0 – 7.5.

Garden cress as a fast growing leafy vegetable is of paramount importance medically and nutritionally. The leaves which are consumed mostly as salads contain significant amounts of iron, calcium and folic acid in addition to vitamin A and C. (Marius,2015). The seeds are also rich in calcium and phosphorus and their consumption has been observed to reduce the incidence of diseases such as prostate cancer, cardiovascular diseases and diabetes (Dannehl *et. al.*, 2012).

Vegetable growers need to consider the importance of sowing methods to crops grown as this affects the agronomic performance of the crops grown. Also, the selection of a suitable planting method plays an important role in the placement of seed at proper planting depth, which ultimately affects crop growth. The growth, yield and quality of vegetables garden cress inclusive, are greatly influenced by the quality and quantity of

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applied fertilizers.Several researchers have shown that organically grown vegetables are tastier and healthier than chemically grown ones due to the quality of the manures used (Stewart *et al.,* 2005). Organic manure such as poultry manure contains nutrient elements that support crop production and enhance the physical and chemical properties of the soil by increasing the water holding capacity of soils, uptake of nutrients, increases in the number and diversity of soil micro organisms particularly in sandy soil conditions. Currently, there is a dearth of information on the growth and yield of Garden cress with respect to sowing methods and application of different rates of poultry manure to enhance the production of the crop. Therefore the objective of this study was to determine the optimum poultry manure rate and the most suitable method of sowing Garden cress in Samaru.

MATERIALS AND METHODS

A field experiment was carried out at the Horticultural Garden of the Institute for Agricultural Research, Ahmadu Bello University, Zaria ($11^0$11'N 7^0 38^0E) and 686m above sea level in the northern guinea savanna ecological zone of Nigeria The treatments consisted of two methods of sowing (broadcasting and drilling and four rates of poultry manure (0, 1.5, 3 and 4.5 tons ha^{-1}), combined in a factorial experiment and laid outin a randomized complete block design (RCBD)replicated three(3) times. The gross plot size (raised beds) was $1m^2$ and the net plot size was $0.25m^2$The field was harrowed and ridged after which plots of raised beds of $1m^2$ were constructed . A local variety of garden cress, Ex–Ajiwa was used, which is fast growing with a yield potential of 6 tons $ha^{-1}$was used for the study. Some ofthe seeds were mixed with 5g of sand and and broadcasted on the plots as per treatment while the remaining seeds were drilled in rows 10cm apart on the plots.Sample of poultry manure used for the experiment was analyzed in the laboratory to determine their chemical properties and the result is shown in Table 1. Similarly, a tubular auger was used to take soil samples randomly at 0 – 30 cm. depths from the experimental site before establishing the trial. The composite sample was analyzed in the laboratory to determine their physical and chemical properties and the result is shown in Table 2. The poultry manure was applied two weeks before sowing as per treatments. It was uniformly spread on the ridges and lightly incorporated into soils with a manual hoe.

Weeds were frequently hand pulled carefully from each plot to avoid damage to crops. There was no incidence of pests and diseases observed during the period of the experiment. Harvesting was done at 3weeks after sowing (WAS) for fresh vegetable yield and at 7WASfor seed yield. Two plants were tagged in each net plot of $0.25m^2$ for periodic measurements and data collection. Parameters like plant height shoot dry matter, fresh vegetable yield, and seed yield were taken. The height of the crop was taken from the ground level of the plant to the apex using a metre rule. For shoot dry matter,five plants outside the net plot were randomly selected and cut at the ground level. The cut samples were then oven dried at 70^0C. The dried samples were then weighed using a Mettler Toledo SB16001 electronic weighing balance and the average was computed and recorded for each treatment combination. All plants in the net plots, which were divided in to two were harvested for the fresh vegetable yield at 3WAS due to the onset of flowering which was induced as a result of a dry spell at 2 WAS. and seed yield weight at 7WAS.The General linear model procedure (GLM) of the statistical analysis system (SAS) package (2012) was used for statistical analysis of all the data collected and

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differences between the treatments means were compared using Duncan Multiple Range Test as described by Duncan (1955). Regression analysis as described by Steel and Torrie (1987) was also carried out to determine the optimum level of poultry manure needed to attain optimum seed yieldof garden cress.

RESULTS

Table 3 shows the growth and yield of garden cress as influenced by sowing methods and poultry manure. There were no significant differences ($P \geq 0.05$) observed between the sowing methods on the plant height, shoot dry matter, fresh yield and seed yield. However, significant differences ($P \leq 0.05$) were observed when poultry manure was applied. Taller plants were observed with the addition of poultry manure in comparison with the control at 5WAS. 4.5 t ha^{-1} of poultry manure significantly produced heavier shoot dry matter than the control and 1.5 t ha^{-1}but was comparable ($P=0.05$) to 3 t ha^{-1}. Similar trend was observed on the fresh yield of garden cress. Poultry manure significantly influenced the seed yield of garden cress, where 3.0 t ha^{-1} significantly produced more seed than the control but was statistically similar to 1.5 t ha^{-1}. There were significant interactions between sowing methods and poultry manure onfresh yield and seed yield (Table 4). At fixed poultry manure rates of 0, 1.5 and 4.5 t ha^{-1} comparable fresh yield were produced with both sowing methods. However, at 3.0 t ha^{-1} broadcasting method significantly produced higher fresh weight than drilling method. Comparable seed yield were observed at fixed poultry manure rates of 0, 1.5 and 3.0 t ha^{-1} when the sowing methods were varied. However, at 4.5 t ha^{-1} drilling method significantly produced higher seed yield than broadcasting method.

DISCUSSION

Though,non significant differences were observed with sowing methods on the growth and yield parameters of garden cress, drilling method produced taller plants, high shoot dry matter and seed yield. This could be attributed to uniform seed distribution which ensured timely germination with reduced competition with weeds at early stage of growth compared to broadcasting method. Also, the higher fresh vegetable and seed yield recorded with drilling method could be due to the fact that the distance among plants was more uniform;therefore each plant had enough space for light interception, whereas in the broadcasting method, the distance between plants may have been very close due to uneven distribution of the plants. The crop generally responded to the application of poultry manure. This could be due to thefact that the soil was low in nitrogen and cation exchange capacity (CEC)as shown in Table 1.Hence, the positive responses to the addition of nutrients which were made available by the poultry manure. The shoot dry matter also increased due to the fact that poultry manure supplied elements necessary for vegetative growth and chlorophyll formation as well as promoting root development which led to efficient production of photosynthates and conductivity of assimilates and water. The above findings agrees with the work of John *et al.* (2004) who reported that poultry manure contained essential nutrients associated with high photosynthetic activities and thus promoted root and vegetative growth. The higher poultry manure rates produced higher fresh vegetable and seed yield. This could have resulted from positive relationship between nutrient contents in the soil and photosynthate production and accumulation. This agrees with the findings of Siemonsma (1991) who reported a linear relationship and high positive correlation between nutrient availability and photosynthate

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accumulation for maximum yield in okra. The significant interactions between sowing methods and poultry manure on the fresh vegetable yield and seed yield of garden cress clearly shows that the non application of poultry manure would have negatively affected these parameters regardless of the sowing method used. The regression analysis of seed yield was linear, this indicates that the optimum poultry manure rate for garden cress had not been reached.

CONCLUSION

Based on the results obtained, it can be concluded that the combination of drilling method of sowing and application of 4.5 t ha^{-1} of poultry manure produced the highest yield of garden cress at Samaru.

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Table 1: Physical and Chemical Properties of the soil sample of the experimental site

Properties	Value
Particle Size Distribution (g/kg)	
Sand	560
Silt	310
Clay	130
Textural class	Sandy loam
Chemical properties	
pH in H_2O (1:25)	6.01
pH in 0.01m $CaCl_2$ (1:25)	5.63
Organic carbon (g kg^{-1})	0.05
Total N (g kg^{-1})	8.60
Available P (mg kg^{-1})	1.18
Exchangeable bases (Meq $100g^{-1}$)	
Ca	2.15
Mg	0.31
Na	0.14
CEC	4.23

Soil samples as analyzed at the Department of Agronomy, Ahmadu Bello University, Samaru, Zaria.

Table 2: Chemical composition of Poultry manure used for the study

Chemical composition	Value
Total Nitrogen (%)	1.98%
Available Phosphorus (%)	0.81%
Potassium (%)	0.21%

Source: Department of Agronomy, Ahmadu Bello University, Samaru, Zaria.

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Table 3: Growth and yield of Garden cress as influenced by sowing methods andpoultry manure during the 2017 rainy season

Treatment	Plant Height(cm) (at 5 WAS)	Shoot dry matter (g) at 5 WAS	Fresh weight at harvest 3 WAS (t ha^{-1})	Seed yield (kg ha^{-1}) at 7 WAS
Sowing Methods (S)				
Broadcasting	34.16	1.04	0.27	240.83
Drilling	34.26	1.09	0.25	291.00
SE±	1.32	0.15	0.02	29.09
Poultry manure (P)				
0	27.92b	1.03b	0.16c	142.50b
1.5	35.71a	1.03b	0.22bc	257.33ab
3.0	37.74a	1.10ab	0.30ab	323.67a
4.5	37.46a	1.47a	0.37a	340.17a
SE±	1.87	0.21	0.03	41.14
Interaction				
P X G	N.S	N.S	*	*

Means followed by the letter(s) within a treatment group are not significantly different at 0.05 level of probability using DMRT. NS = Not significant.

Table 4: Interaction of sowing methods and poultry manure on Garden cress fresh yield and seed yield at 3WAS and 6WAS respectively during the 2017 rainy season at Samaru.

	Poultry manure (PM) t ha^{-1})			
Sowing Methods (S)	0	1.5	3.0	4.5
Fresh yield (kg ha^{-1})				
Broadcasting	0.17c	0.23b	0.36a	0.33ab
Drilling	0.16c	0.22bc	0.23b	0.40a
SE±		0.03		
Seed yield (kg ha^{-1})				
Broadcasting	135.67c	166.67bc	394.67ab	266.33b
Drilling	149.33c	348.00ab	252.67b	414.00a
SE±		39.15		

Means followed by the letter(s) within a treatment group are not significantly different at 0.05 level

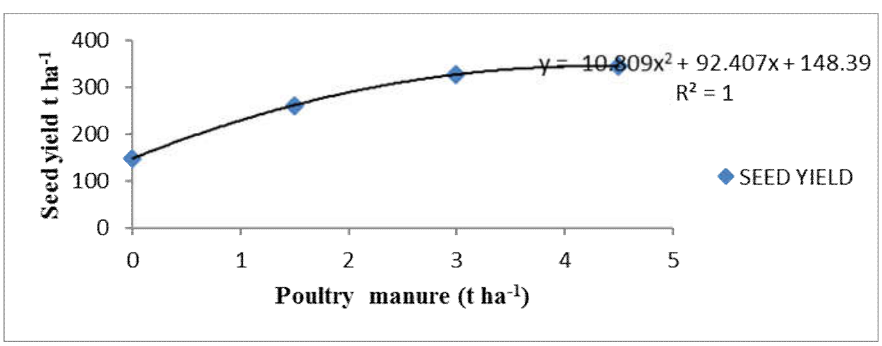

Figure 1: Regression of Garden Cress seed yield on poultry manure.

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Yield and Yield Components of Tomato Varieties as Affected by Irrigation Interval and Stand Density in Nigerian Savanah

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Abstract

Field experiments were conducted Institute of Agricultural Research, Ahmadu Bello University stations in Samaru and kadawa of the northern savannah agro-ecological zones, during 2017/2018 dry season to study the yield and yield components of tomato varieties under different irrigation interval and stand density. The treatment consisted of two tomato varieties (UC-82B and ROMA-VF), three irrigation interval (5, 10 and 15days) and two stand densities (27,500 and 55,000 plants stand ha^{-1}) laid in RCBD in split block arrangement and replicated four times. Data was collected on number of fruit, fruit weight, fruit diameter, and total fruit yield. Data collected were subjected to anova test of significant using SARS software. Varietal effect revealed that, UC-82B showed superiority on number of fruit, fruit weight, fruit diameter, and total fruit yield in tons ha^{-1} in both experimental locations. Similarly, irrigation treatment was significant on all the yield and yield components with a linear trend for 5days irrigation interval at Samaru location.. However, stand density treatment was significant on number of fruit at Samaru where 55,000 plant stand ha^{-1} recorded the highest value. While 27,500 stand ha $^{-1}$ was significant on fruit weight at both locations. 55,000 plant stand ha^{-1}had highest total fruit yield in tons ha^{-1}at both locations but was significant at Samaru. Therefore, application of irrigation water at 5days interval using UC-82B was found to be the best for number of fruit, fruit diameter and total fruit yield in Samaru, though extending irrigation days to 15days recorded higher fruit yield at Kadawa.

Keywords: Plant Density, Irrigation Interval, Tomato and Variety

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill*) belongs to the family *Solanaceae.* It is believed to have originated in Peru-Ecuador areas where it spread as a weed throughout parts of America and then domesticated in Mexico (Anons, 2011). It is one of the most widely eaten vegetables in the world, fresh or in processed forms. Tomato consumption has been associated with prevention of several diseases (Willcox *et al.,* 2003). Tomato was introduced to Nigeria in the 19th century and is now the most widely grown and most important vegetables (Ramalan *et al.*, 1998). In Nigeria, tomato is mostly cultivated in the semi-arid region during the cool dry season (harmattan period) using irrigation. High temperatures have been proved to have a detrimental effect on the delicate tomato fruit set process (Harel *et al*., 2014) hence the production of tomato is limited to the cooler period of the year (Rodriguez, 2007). As such, the availability of fresh tomato is always limited during the hot period (Wali and Kabura, 2013; Kabura *et al*., 2009). Tomato is cultivated all over the world and is a widely consumed vegetable. World production is more than 177,042,359 million metric tons with China leading (56.423811 metric million tons), followed by USA (15.5 metric million tons). Africa produced 10.8% of world production with

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Morocco (12.31 metric million tons) leading producer in Africa, Nigeria is the fourth largest producer in Africa and leads in west Africa sub region with an estimated output of 2,9243,228 metric million tons and average yield of 30-40 tons ha^{-1} (FAO, 2016).Tomato is a vegetable crop with variable growth habit. Varieties could be erect or prostrate. The plant grows to a height of about 2-4 meters tall with coarse solid stems hairy and granular, the crop has vigorous tap root system up to 50cm depth with dense, lateral advantageous roots (IFOAM, 2008).

MATERIALS AND METHODS

Field trials were conducted during the 2017/2018 dry season at the Research Farm of the Institute for Agricultural Research, Samaru (11^0 11'N, 07^0 38'E, 686 meters above sea level) in the Northern guinea savannah and Irrigation Research Station, Kadawa (11^0 39,N 08 ^{0} 02E, 500 meters above sea level) in the Sudan savanna ecological zone of Nigeria. The soils of the experimental fields were collected randomly from three points at the depth of 0-30cm prior to land preparation for laboratory analysis on soil physic-chemical properties. The experiment consisted of factorial combinations of three irrigation intervals (5, 10 and 15 days), two stand densities (1 and 2 plants $stand^{-1}$) and two tomato varieties (ROMA-VF and UC82-B) laid in a randomized complete block (RCBD) and arranged in a split block in four times replication. The two stand density has population of 27,750 and 55,500 plant ha^{-1} respectively. Data was collected on number of fruit, fruit weight, fruit diameter, and total fruit yield. Metrological data were also collected from the two locations. The data collected were subjected to statistical analysis of variance (F-test) as described by Snedecor and Cochran (1967) to test significance of treatment effects. The treatment means were compared using the Duncan's Multiple Range (DMR) test (Duncan, 1955).

For this experiment, ROMA-VF and UC82-B varieties were used. ROMA-VF: This is an open pollinated variety with a growth height (121cm tall) and large number of branches. It matures in 65-75 DAT with a potential yield of 25-30 ton ha^{-1}. They are resistant to common disease and the fruits are egg or pea shaped red to yellow in colour with few seeds. The variety is good for canning. UC 82-B: This is semi determinant, short or medium in height with few numbers of branches. It matures in 60-70 days with potential yield of about 35 $tonha^{-1}$. The fruits are medium – small in size, round and red. It is a processing type with excellent storability when harvested green, less heat tolerant and resistant to cracking.

RESULTS

The effects of tomato varieties, irrigation interval and stand density treatments on number of fruit, fruit weight, fruit diameter and total fruit yield of tomato at Samaru and Kadawa during 2017/2018 dry season are presented in table 1. UC-82B variety had the highest values ofnumber of fruit, fruit weight, fruit diameter, and total fruit yield. at Samaru and Kadawa locations with significant difference at both locations. Irrigation interval of 5 days had the highest values of number of fruit, fruit weight, fruit diameter, and total fruit yield at Samaru locations while 15 days interval irrigation had the least values of all parameters. At Samaru, yield and yield components of 5 days irrigation interval was significantly different from 10 and 15 days interval while at Kadawa, 5 days irrigation interval had highest number of fruit, fruit diameter and fruit weight and 15 days interval had the highest total yield but there was no significant difference in the yield and yield components of5, 10 and 15 days irrigation interval. However, 55,000 stands densities had highest number of fruits in Samaru and Kadawa locations

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with significant differences while 27,000 stand densities had highest values in fruit weight with significant difference at both locations. At Samaru location, 55,000 stand densities had numerical highest valueof fruit diameter but was not significantly different from 27,000 stand density while both stand densitieswere at par for Kadawa location. 55,000 stand densities had the highest total fruit yield at both location with significant difference at Samaru only.

Also from table 1, the interaction between variety and irrigation interval, variety and stand density, irrigation and stand density and variety, irrigation and stand density showed no significance in both locations.

DISCUSSION

Varietal effect revealed that UC-82B had higher yield and yield component in terms of number of fruits,fruit diameter, average fruit weight and fruit yield in tons ha^{-1}than Roma VF tomato variety. These finding confirm the report of Isah *et al.*(2008) whichreported that UC-82B tomato variety hadhigher yield and yield components than Roma VF variety. Similarly, varying irrigation interval hadeffect on number of fruit, fruit weight, fruit diameter and total fruit yield. Increasefrom 5 days to 15days interval significantly decreasedboth growth and yield parameters at Samaru location. These results indicated that after 10days, soil moisture content in the root zone became in adequate for the plant growth and development, which could be attributed to loamy and slightly acidic soils found and the climatic factors during the growing season at Samaru. Similar observations were made by Rilwanu (1999); Rodriguez *et al.*(2010) and Abubakar (2014) who concluded that irrigation that replenish60% of moisture depletedevery 5days gives better results in terms of yield and water use efficiencies. However, at Kadawa increasing irrigation interval from 5 to 10 and 15days had no significant increase in growth and yield parameters which could be attributed to water holding capacity of clay loam soils, high water table and extremely low temperature during the season in the location. Thisresult agreeswith the finding of Hussaini *et al*. (2013). However, most of the yield parameters responded positively to change in stand density per hectare. Increasing stand density from 27,500 to 55,000 plant stand ha^{-1} resulted to a significant difference in number of fruit, fruit diameter and fruit yield.Number of fruit and Fruit yield weresignificantly different when stand density was increased from 27,500 to 55,000 plant stand ha^{-1} at Samaru. This result agreed with the finding of Rilwanu (1999) that doubling the stand density implies doubling plant population and proportionately to higher yield in tons per hectare.

However, 27,500 plant stand ha^{-1} recorded the higher stand significantly different fruit weight in grammes than 55,000 plant stand ha^{-1}. This result is in accordance with the findings of Law-ogbomo and Eghaverba (2009) and Nguyen *et al.*(2015). According to Wold *et al.*(2004), with an increased plant density per unit area, plants compete for essential growth factors such as nutrients, light and water with direct influence on yield and fruit quality.

CONCLUSION

Tomato variety UC-82B showedsuperiority overRoma VF on all the yield and components in this study. The study further confirmedthe valuable contribution of irrigation interval and stands density, where 5days interval and 55,000 plant stand ha^{-1}hadthe best results of yield parameters in Samaru location, while increasing irrigation interval to 10days prove the best due soil-water table difference in Kadawa.

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Table 1: Number of fruit, fruit weight, fruit diameter and total fruit yield of tomato varieties as influenced by irrigation interval and stand density during 2017/2018 dry season at Samaru and Kadawa

Treatment	Fruit number	Fruit weight (g)	Fruit diameter (cm)	Total fruit yield (ton ha^{-1})	Fruit number	Fruit weight (g)	Fruit diameter (cm)	Total fruit yield (ton ha^{-1})
	Samaru				**Kadawa**			
Variety								
Uc 82B	495.9a	72.5a	4.1a	19.9a	453.6	145.6a	4.6a	20.7a
ROMA VF	419.3b	62.9b	3.7b	17.0b	408.9	117.3b	4.3b	17.7b
SE ±	16.372	3.241	0.125	0.433	19.119	6.925	0.079	0.758
Irrigation Interval (days)								
5	539.4a	85.3a	4.4a	21.9a	456.6	128.5	4.5	19.9
10	450.6b	70.0b	3.6b	19.6b	447.8	128.1	4.5	17.6
15	382.8c	47.7c	3.6b	13.8c	389.6	137.6	4.4	20.3
SE ±	20.051	3.969	0.153	0.530	23.415	8.482	0.097	0.929
Stand Density (plants ha^{-1})								
27,500	423.2b	83.6a	3.8	17.0b	416.4	171.3a	4.5	18.5
55,000	492.0a	51.8b	3.9	19.8a	446.3	91.6b	4.5	20.0
SE ±	16.372	3.241	0.125	0.433	19.119	6.925	0.079	0.758
Interaction								
V*I	NS	NS	NS	NS	NS	NS	NS	NS
V*D	NS	NS	NS	NS	NS	NS	NS	NS
I*D								
V*I*D	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) in the same column are not different statistically at *P=0.05* using DMRT. NS= Not significant *= Significant at ($P \leq 0.05$)

Table 2: shows average temperature, relative humidity and rainfall of institute for Agricultural Research, Samaru Abu, Zaria for the month of October, 2017 to May 2028

Month	Temperature (°C)		Relative Humidity (%)		Rainfall(Mm)
	MAX	MIN	10AM	4PM	
October	44.09677419	18.09677	64.4516129	50.12903	0.096774
November	34.2	11.96667	18.03333333	16.1	0.00
December	31.35483871	12.48387	16.90322581	12.80645	0.00
January	30.16129032	13.00	17.70967742	14.2581	0.00
Febuary	36.39285714	18.00	20.39285714	16.1071	0.00
March	39.78686636	20.00	13.00	9.12903	0.00
April	38.13333333	22.00	36.2173913	18.4333	0.276667
May	35.32258065	23.00	64.06451613	47.2258	3.357312

Source: Metrological Unit Institute for Agricultural Research Ahmadu Bello University, Zaria.

Response of Maize (*Zea mays* L.) to Integrated Use of Liquid Organic NPK, Inorganic NPK and Micronutrients Fertilizers in the Sudan Savannah Zone of Nigeria

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Abstract

Research was conducted during 2016 rainy seasons at the research farm of Binyaminu Usman Polytechnic, Hadejia, Jigawa State (latitude 12^0 22′ N and longitude 7^0 46′ E) to assess the influence of liquid organic and inorganic NPK fertilizers, micronutrients and integrated nutrients management on the yield and yield components of maize. The treatments comprised of inorganic NPK fertilizer (120::60:60kg ha^{-1}) alone or with micronutrients, liquid organic NPK fertilizer (LOF) alone (5 $lit.ha^{-1}$) or with micronutrients, 25% LOF + 75% inorganic NPK, 25% LOF + 75% inorganic NPK + micronutrients, 50% LOF + 50% inorganic NPK, 50% LOF + 50% inorganic NPK + micronutrients, 75% LOF + 25% inorganic NPK, 75% LOF + 25% inorganic NPK + micronutrients, micronutrients only (300 $g.ha^{-1}$) and the control plot with no fertilizer. SAMMAZ 27 was used as a test crop. The treatments were laid in a Randomized Complete Block (RCB). The results showed that full inorganic NPK (120:60:60) in combination with micronutrients outperformed all the other treatments in yield characters. Liquid organic NPK alone (5 $lit.ha^{-1}$) was superior only to control treatment in most characters assessed. The combinations of liquid organic NPK with inorganic NPK and micronutrients fertilizers significantly affected the yield and yield components at the study area. The result further indicated that in most instances 50% LOF (2.5 $lit.ha^{-1}$) + 50% inorganic NPK fertilizer + 300 $g.ha^{-1}$ micronutrients and 25% LOF (1.25 $lit.ha^{-1}$) + 75% inorganic NPK fertilizer + 300 $g.ha^{-1}$ micronutrients were at par with inorganic NPK fertilizer alone (120:60:60) and inorganic NPK fertilizer + 300 $g.ha^{-1}$ micronutrients. This showed that integrated nutrient management involving liquid organic NPK and inorganic NPK fertilizers along with micronutrients resulted in good performance of maize. The highest grain yield of 1796 $kg.ha^{-1}$ and 1442 $kg.ha^{-1}$ were recorded in plots treated with full inorganic NPK with micronutrients, while the lowest grain yield of 363$kg.ha^{-1}$ and 418 $kg.ha^{-1}$ were recorded from control plots.

INTRODUCTION

Maize (*Zea mays* L.) is an annual crop belonging to the genus *Zea* and family Poaceae.. Maize is an important cereal crop in the world and ranks third, following wheat and rice in the world's cereal crops production (ref.). Maize is consumed directly by man as a source of dietary carbohydrate and is used to feed livestock. It also serves as raw materials for pharmaceutical and other industries, (USDA, 2005). The objectives of this study were determine the influence of liquid organic NPK fertilizer on the performance of maize and evaluate the effect of combined use of liquid organic, inorganic and micronutrient fertilizers on the growth and yield of maize Abdurrahman (2006)

MATERIALS AND METHODS

The experiment was conducted at Binyaminu Usman Polytechnic Farm, Hadejia, Jigawa State (Latitude 12^0 22′ N and Longitude 7^0 46′ E) during 2016 raining season. Composite soil samples of the experimental site was formed by collecting ten soil samples randomly at the depth of 0 – 30cm using soil auger before planting and fertilizer application. The samples were bulked together and subjected to analysis for physico-chemical properties using standard procedures (Table 1).The experiment comprised of a maize variety (SAMMAZ 27) and twelve fertilizer treatments of liquid organic NPK fertilizer (LOF), inorganic and micro-nutrients fertilizers combinations as described below.

i. Full inorganic NPK fertilizer (NPK 120:60:60kg ha^{-1})

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ii. Full inorganic NPK fertilizer (NPK 120:60:60) + micronutrient (300g/ha)
iii. Full LOF (5litres/ha)
iv. Full LOF (5litres/ha) + micronutrient (300g/ha)
v.75% LOF (3.75l/ha) + 25% inorganic NPK fertilizer
vi.75% LOF (3.75l/ha) + 25% inorganic NKP fertilizer + micronutrient (300g/ha)
vii.50% LOF (2.5l/ha) + 50% inorganic NPK fertilizer
viii.50% LOF (2.5l/ha) + 50% inorganic NPK fertilizer + micronutrient (300g/ha)
ix.25% LOF (1.25l/ha) + 75% inorganic NPK fertilizer
x.25% LOF (1.25l/ha) + 75% inorganic NPK fertilizer + micronutrient (300g/ha)
xi. Micronutrient (300g/ha)
xii. Control (No fertilizer)

Treatments were laid out in a randomized complete block design (RCBD) and replicated four times. The land was cleared and harrowed and then ridged using Ox - driven ridger. The seeds were sown manually by hand at the rate of 2 seeds per hole at an intra and inter row spacing of 0.25m and 0.75m, respectively between stands. After germination the seedlings were thinned to 1plant/stand two weeks after sowing (WAS) to give a plant population of 53,333 plants per hectare. For the inorganic fertilizer, NPK (20-10-10) was used to supply the complete doses of P and K of each treatment and half dose of N during sowing. While the remaining half of N of each treatment was applied 4 WAS using Urea (46% N). The fertilizer was side placed between stands and buried 5cm deep. For the liquid organic NPK fertilizer and micronutrient fertilizer treatments, the quantity required for each treatment was divided into three equal doses and applied directly to the soil very close to the roots at 2 WAS and subsequently at 4 WAS and 6 WAS. The mixing ratio of the liquid organic NPK fertilizer used was 0.5 litre of liquid organic NPK to 50 litre of water as recommended by the producer. The micronutrient fertilizer at the rate of 300g/ha was incorporated in to the mixture and applied together.

Data were collected on cob yield/hectare (kg), cob length (cm), cob diameter (mm), kernel depth (mm), number of kernel rows/cob, grains weight/cob (g), grain yield/hectare (kg), 100-grain weight (g), harvest index, shelling percentage and stover yield/hectare (kg). Data collected from the experiment was subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967). Duncan Multiple Range Test (Duncan, 1955) was used to compare the treatment means when there is significant difference in between the treatments.

RESULTS

The result of physico-chemical properties of soil of the experimental site is presented in Table 1. The result indicated that the soil of the location was sandy loam, pH was moderately acidic (6.8), organic carbon was low (0.7 g/kg), organic matter content was very low (1.2 g/kg), total nitrogen was also very low (0.39 g/kg), available phosphorus was moderate (13.75 mg/kg), potassium content was also moderate (0.38 cmol/kg) suggesting the need for fertilizer amendment for maize production in the study area.

Number of kernel rows per cob

Kernel rows per cob as affected by the treatments are presented in Table 2. The results revealed a significant statistical difference ($P \leq 0.05$) between the treatments on the character. The highest number of kernel rows per cob was recorded with full inorganic fertilizer + micronutrient followed by 25% LOF + 75% inorganic fertilizer + micronutrient, full inorganic fertilizer and 50% LOF + 50 % inorganic fertilizer + micronutrient,

Cob length (cm)

Table 3 present the effects of treatments on cob length. The results showed a significant statistical difference ($P \leq 0.05$)

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between the treatments as per the character. Observations revealed that full inorganic fertilizer + micronutrient, full inorganic fertilizer, 50% LOF + 50% inorganic NPK + micronutrient, 25% LOF + 75% inorganic NPK + micronutrient, and 75% LOF + 25% inorganic NPK + micronutrient were at par and produced longest cobs, followed by 50% LOF + 50% inorganic NPK, 25% LOF + 75% inorganic NPK. Moreover observations showed that application of micronutrient solely resulted in a significant difference over the control.

Grain weight per cob (g)

The effect of treatments on grain weight per cob is presented in Table 4. The results revealed that grain weight per cob was significantly ($P \leq 0.05$) affected by the treatments at the study sites. The results almost follows a unique trend, highest grain weight per cob of 124g was recorded with full inorganic NPK +micronutrient, followed by full inorganic NPK and 50% LOF + 50% inorganic NPK that yielded 111g Observations revealed that grain weight per cob recorded with treatment combinations between LOF and inorganic fertilizer were at par with that of full inorganic NPK fertilization.

Grain yield (kg ha^{-1})

The effect of treatments on grain yield per hectare is presented in Table 5. The result revealed that, grain yield per hectare was significantly affected by the treatments. Full inorganic NPK + micronutrient recorded higher grain yield/ha of 1796.29kg and 1442kg followed by full inorganic NPK without micronutrient and 25% LOF + 75% inorganic NPK with micronutrient which recorded grain yield of 1424.07kg and 1422.22kg. A grain yield differences of 79.8% was observed between full inorganic fertilizer and control. Similarly a grain yield differences of 61% between full LOF and control was also observed. Control plots recorded the lowest grain yield/ha of 362.9 kg. The results showed 292 and 198 % yield difference between full inorganic fertilizer treatments and the control and 154 and 6% yield difference between LOF and the control, The effect of micronutrient fertilization on grain yield per hectare was significant/ The results showed that grain yield per hectare was not significantly ($P \geq 0.05$) affected by micronutrient fertilization. However all treatments in combination with micronutrient recorded higher grain yield over same treatments without micronutrient.

DISCUSSIONS

Effect of Inorganic NPK Fertilizer on Growth and Yield of Maize

Observations recorded from this study revealed that both growth and yield characters assessed significantly increased with increase in NPK rates up to application of complete recommended rate (120:60:60 kg/ha NPK) as recommended by Edensor *et al*., (1989). The result of the experiment also revealed that application of NPK fertilizer significantly promoted yield characters of maize. This is in line with findings of Singh *et al*. (2009) who revealed that yield characters of maize were significantly higher through the application of 100% nitrogen from inorganic sources. This is due to the fact that nitrogen applied from inorganic source becomes more readily available and absorbable to the crop as compared to nitrogen from organic source that need to be decomposed and mineralized before the crop absorbed it. Moreover its known that nitrogen favourably affects maize growth through increasing cell division, expansion and elongation of all morphological parts of the crop.

Effect of Liquid Organic NPK Fertilizer on Growth and Yield of Maize

The result of this study revealed that application of sole liquid organic NPK fertilizer significantly increased most of the growth and yield characters of maize only above the control treatment. The

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findings of this study revealed that growth and yield characters were significantly influenced due to application of liquid organic NPK fertilizer mostly in combination with inorganic NPK. These characters involved Number of kernel rows/cob, cob yield/ha, grain yield/ha, grain weight/cob increased significantly due to application of liquid organic NPK. The finding of this study supported the observations reported by Eureka *et al*. (2013), who carried out an experiment to assess the response of maize to liquid organic fertilizer. Their findings revealed that application of 15l/ha liquid organic fertilizer produced significant yield difference than the other rates. This could be attributed to the role played by the LOF in acting as a substrate for micro-organisms which helped in mobilization and mineralization of essential nutrients, biological stimulation of growth and plant visor and decreased in crop maturity period...

Effect of Micronutrient Fertilization on Growth and Yield of Maize

Micronutrients are essentially required by crops in small quantity and play a vital role in the plant metabolic processes (Marcher, 1995). The results obtained from this study revealed that application of micronutrient enhanced growth and yield of maize compared to treatments without micronutrient, though the differences were not statistically significant... This could be due to the fact that micronutrient are relatively required by crops in small amounts and may be supplied by the soil, and could also be attributed to the amounts of micronutrient in the LOF used in the experiment that may be enough to satisfy the requirements of the crop. The result shows that application of micronutrient fertilizer significantly enhanced some yield characters such as cob length and cob yield/ha. Results showed that there was 50.23% and 27.14% increase in cob yield between sole micronutrient and the control. This was due to the roles played by these nutrients in the plant metabolic processes which involved cell wall development, respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation.

Combined Effects of Inorganic, Liquid Organic NPK and Micronutrient Fertilizers on Growth and Yield of Maize

The result of this study revealed that, the integrated nutrients management enhanced positively the yield characters of maize, though there was no regular trend in the effects of the treatments combinations in affecting the characters evaluated in this research. In most cases application of 25% liquid organic NPK + 75% inorganic fertilizer with or without micronutrient significantly enhanced growth and development of maize over liquid organic NPK alone and control treatments. Though, almost all the treatment combinations involving the three sources of nutrients evaluated in this study had shown a positive influence on the test crop.

CONCLUSION

Based on the results obtained in this study, the use of recommended NPK fertilizer (at the rate of 120:60:60kg ha^{-1}) or 25% LOF + 75% inorganic fertilizer could be recommended for use by farmers in the study area.

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Table 1: Physico-chemical properties of soils of the experimental site 2016 raining season

Physical Composition (%)	
Sand	60.28
Silt	23.18
Clay	16.54
Textural Class	Sandy loam
Chemical Composition	
pH in H_2O	6.80
Organic Carbon (g/kg)	0.70
Total Nitrogen (g/kg)	0.39
Available Phosphorus (mg/kg)	13.75
Organic Matter (g/kg)	1.20
Exchangeable Bases (cmol/kg)	
Ca	3.69
Mg	1.17
K	0.38
Na	0.49

Analyzed in the Soil Science Department, Faculty of Agriculture, Bayero University Kano

Table 2: Effect of Fertilizer Treatments on Number of Kernel Rows per cob of Maize 2016 raining season

Treatment	**Number of Kernel Rows/Cob**
Full IF + man	15.25a
Full IF	14.75ab
Full LOF + mn	14.50abc
Full LOF	13.75abc
75% LOF + 25% IF + mn	14.25abc
75% LOF + 25% IF	13.75abc
50% LOF + 50% IF + mn	14.75ab
50% LOF + 50% IF	14.25abc
25% LOF + 75% IF + mn	15.00ab
25% LOF + 75% IF	14.25abc
Micronutrient	13.50bc
Control (No fertilizer)	13.00c
Level of significance	*
SED	0.669

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT

Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability

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Table 3: Effect of Fertilizer Treatments on and Cob Length (cm) of Maize 2016 raining season

Treatment	Cob Length
Full IF + mn	13.47a
Full IF	13.40a
Full LOF + mn	11.32de
Full LOF	10.75ef
75% LOF + 25% IF + mn	13.25a
75% LOF + 25% IF	11.95cd
50% LOF + 50% IF + mn	13.25a
50% LOF + 50% IF	12.27bc
25% LOF + 75% IF + mn	13.22a
25% LOF + 75% IF	12.92ab
Micronutrient	12.00cd
Control (No fertilizer)	10.17f
Level of significance	**
SED	0.3274

Table 4: Effect of Fertilizer Treatments on Cob Yield per Hectare (kg) and Grain Weight per Cob (g) of Maize at Hadejia

Treatment	Cob Yield / Hectare	Grain Weight /Cob
Full IF + mn	2155.56a	124.00a
Full IF	1708.89b	111.00ab
Full LOF + mn	1325.93cd	102.50abc
Full LOF	1040.00de	89.50bcd
75% LOF + 25% IF + mn	1411.12bc	92.80bc
75% LOF + 25% IF	1264.45cd	104.80abc
50% LOF + 50% IF + mn	1511.11bc	102.50abc
50% LOF + 50% IF	1332.59cd	111.00ab
25% LOF + 75% IF + mn	1706.67b	105.50abc
25% LOF + 75% IF	1342.22cd	88.00bcd
Micronutrient	875.56e	82.00cd
Control(No fertilizer)	435.56f	65.20d
Level of significance	*	*
SED	138.631	11.15

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT

Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability).

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Table 5: Effect of Fertilizers Treatments on Maize Grain Yield (kg ha^{-1}) during 2016 raining season

Treatment	kg ha^{-1}
Full IF + mn	1796.29a
Full IF	1424.07b
Full LOF + mn	1175.18cd
Full LOF	922.22efg
75% LOF + 25% IF + mn	1101.85cde
75% LOF + 25% IF	850.01fg
50% LOF + 50% IF + mn	1331.48bc
50% LOF + 50% IF	1057.78def
25% LOF + 75% IF + mn	1422.22b
25% LOF + 75% IF	1118.52cde
Micronutrient	759.34g
Control (No fertilizer)	362.96h
Level of significance	*
SED	109.536

Means followed by the same letter (s) within a column are not significantly different at 5% level of probability using DMRT

Key: IF (Inorganic NPK fertilizer), LOF (Liquid Organic NPK Fertilizer), mn (Micronutrient), * (Significant at 5% level of probability), ** (Significant at 1% level of probability) .

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Effects of Poultry Manure and Sowing Methods on the Growth and Yield of Roselle (*Hibiscus sabdariffa* L.) at Samaru, Nigeria

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Abstract
Field experiment was conducted during the wet season of 2017 at the horticultural garden of Institute for Agricultural Research (I.A.R), Ahmadu Bello University, Zaria to study the effects of poultry manure rate and sowing method on the performance of roselle (Hibiscus sabdariffa L.). The treatments consisted of four poultry manure rates (0, 2, 4 and 6 t/ha) and two sowing methods (dibbling and drilling). a significant response was noted on plant height, number of leaves and leaves area at later stages of growth of the crop where applications of 4- 6 t/ha /ha of poultry manure gave higher mean values. Higher fresh and dry leaves yields were obtained when 4 t/ha of poultry manure was applied. The two sowing methods were significant on plant height and leaf area at 6 WAS. Drilling and dibbling methods were at par when fresh and dry yields were assessed. Based on this investigation, it was observed that application of 4 t/ha of poultry manure using dibbling sowing method resulted to efficient growth and yields of roselle in Samaru and environs under rain fed condition.
Keywords; *roselle, poultry maure, dibbling and drilling*

INTRODUCTION

Roselle belongs to the family *Malvaceae* and originates from India and Malaysia. Seeds are said to have been brought to the New World by African slaves and it is now among the common garden crop in Florida ((Andrews, 1952). It is an erect and branched annual sub-shrub, (0.5-3 m tall) with a strong tap-root system. The flowers are borne on very short peduncles in the axils of the upper leaves. It is intercropped among other vegetable or field crops such as sorghum and sesame (Kumar, *et al.* 1986). It is also grown along field margins as a boarder crop. The commercially important part of the plant is the fleshy calyx (sepals) surrounding the fruit (capsules). The whole plant can be used as beverage, animal feed or the dried calyces can be soaked in water to prepare a colorful cold drink, or may be boiled in water as a hot drink. Seeds, capsules and stems are used in traditional medicines. (Ahmed and Nour 1981, Anons, 1999 and Mohammed *et al.* 2007). Roselle is quite hardy and grows well in most soils that are well drained. It tolerates poor soil, and is often grown as a supplemental rather than a primary crop. It requires 4-8 months and a night temperature not below 21^{o}C. In addition, it requires 13 hours of sunlight during the first 4-5 months of growth to prevent premature flowering. Roselle requires a monthly rainfall ranging from 5-10 inches in the first 3-4 months of growth. Dry periods are desirable in the last month. Delayed harvest should be avoided as rainfall or high relative humidity reduces the quality of the calyces and yield. Despite the importance of roselle in Nigeria, yield and quality of the calyces and seeds from farmers' fields are usually low. This could be attributed to inadequate nutrients supply and sowing methods among others. Farmers cultivate the crop with little or no attention to the crop nutrients source and rate. This necessitates the need to investigate the rate required by the crop irrespective of the source. Moreover, research works on the use of organic manure on roselle are scanty. Research efforts are therefore required to formulate and recommend manure requirement for sustainable production of this crop. Poultry manure is a very valuable nutrient source that improves and sustains soil fertility in a long run due to its slow release of its essential nutrients to plants. On the other hand, poultry manure, though costlier, it is more affordable and less bulky compared to other organic manures.

The crop is commonly cultivated with less attention to the methods of sowing. Appropriate sowing method is a prerequisite for optimum performance of the crop as overcrowding resulted to shattering effect and unnecessary competition among the crop. Likewise, low population encourages weed growth and subsequent poor yield. Drilling and dibbling are common sowing methods for vegetable crops, hence the need to suggest the best method that would ensure proper growth and development of the crop. Based on the above, this work was conducted to determine the appropriate poultry manure rate and best sowing method for optimum growth and yield of Roselle.

MATERIALS AND METHODS

The experiment was conducted during the 2017 wet season at the Horticultural garden of Institute for Agricultural Research (I.A.R) of Ahmadu Bello University, Zaria. (11°, 11° N, 78° 8°) and 686 m above sea level. The treatments consist of four of poultry manure rates (0 kg/ha, 2 kg/ha, 4 kg/ha and 6 kg/ ha) and two planting methods (dibbling and drilling). The treatments were factorially combined and laid out in Randomized Complete Block Design (RCBD), replicated three times. Soil samples were randomly taken from the undisturbed field at 0-15cm and15-30cm from various points at the experimental site. Soil samples and poultry manure were analyzed in the laboratory as indicated in tables 1 and 2.

The experimental field was harrowed and ridged 75cm apart and marked out into plots. The gross plot size was 8 m^2 (4 m x 2 m) and the net plot was 4 m^2. The red *zobo* seeds were sown as per treatment after rainfalls on the prepared land. Two hoe weeding were carried out at 3 and 6 weeks after sowing. Data were collected from the field on growth and yield attributes at

2, 4,6 and 8 weeks after sowing. Analysis of variance (ANOVA) was done and means were determined using Duncan Multiple Range test (Duncan, 1955

RESULTS

Plant height

Table 3 shows the effects of poultry manure, sowing method and their interaction on plant height of Roselle. There was no significant response due to varied application of poultry manure at 2 and 4 WAS. However, at later stages of growth, significant differences were noted. At 6 WAS, plant height increase with increment of poultry manure from 2- 6t/ha whereas at 8 WAS, the increment was up to application of 4t/ha beyond which no further increase was noted.

The effect of sowing method was only significant at 6 WAS where dibbling resulted in taller plants compared to drilling method. A significant interaction between poultry manure and sowing method was noted only at 6 WAS.

Table 4 shows the interaction between poultry manure and sowing methods on plant height at 6 WAS. At varied rate of poultry manure, it was observed that plant height increases up to the application of 6 t/ha in dibbled plots where as in drilled plots, the increase was up to application of 4t/ha only. Holding poultry manure constant, it was observed that no significant differences were noted when 0 and 4 t/ha poultry manure were applied. However, application of 6 t/ha resulted in significantly taller plants in dibbled plots only.

Number of leaves

Table 5 shows the effects of treatments and their interaction on number of leaves of roselle. There was no significant

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response due to varied application of poultry manure at 2 and 4 WAS. The effect of poultry manure shows only a significant difference at 8 WAS only. At 6 WAS, number of leaves increases with increment of poultry manure from 2 - 6t/ha whereas at 8 WAS, the increment was up to application of 4 t/ha beyond which no further increase was noted.

The effect of sowing method was only significant at 6 WAS, where drilled sown plants had more number of leaves compared to plants in the dibbled plots. No significant interactions between poultry manure and sowing method on number of leaves

Leaf area

Table 6 shows the effect of poultry manure, sowing method and their interaction on leaf area of the crop. A significant response was noted throughout the sampling period except at 2 WAS. At 4 WAS, application of poultry manure from 2 – 4 t/ha resulted in larger leaf area beyond which no further increase was recorded similar observations was noted at 6 WAS, while 8 WAS application of 0 - 2 t/ha resulted in larger leaf area t beyond which there no further increase was noted. The effect of sowing method was significant only at 6 WAS where dibbling method resulted in higher leaf area as compared to drilling method. There were significant interactions between poultry manure and sowing method throughout the sampling period. Table 9 shows the interaction between poultry manure as shown in Table 9 indicated an increase in leaf area when poultry manure rate was increase from 2- 4 t/ha beyond which no further increase was observed on dibbled plots. While in drilled plots, a statistically similar and larger leaf area was noted when 2- 6 t/h were used relative to when no manure was applied. At constant rate of poultry manure, 4 t/ha gave higher value and similar value with 6/ha while drilled plants 2 t//ha had higher value whereas 4 and 6/ha had similar lower value and the least was noted when no manure was applied.

Fresh and dry leaves yields

The effect of poultry manure, sowing method and their interaction on leaves fresh yield was presented on table 15, No significant difference was observed between control and where 2t/ha of the poultry manure was applied. However, when the rate was increased to 4t/ha a higher yield was recorded beyond which no significant increase was noted. No significant differences were observed on fresh yield due to varied sowing methods. The interaction between poultry manure rate and sowing method on leaves fresh yield of the crop was not significant.

DISCUSSION

The non significance response of poultry manure on plant height and number of leaves at initial stages of growth indicated that at that stage the need for nutrients is less and the crop rely more on the limited inherent soil nutrients due to the slow decomposition and mineralization of the applied poultry manure. As the crop grow further the nutrients needs increases as shown by the significant response at 6-8 WAS at this stage the crop need more nutrient for assimilation, hence the need for a higher rate resulting in more vegetative growth as observed in more number of leaves when 4/ha was applied at 8 WAS. Likewise, at this period, the manure is well decomposed and easily absorbed by the plant roots. However, an increase in leaf area with the application of 4 t/ha and 6 t/ha, at 4 and 6 WAS, respectively, could be attributed to the fact that the vegetative growth of the crop is at its peak at 4 WAS, hence the need for more nutrients for efficient photosynthesis and assimilate distribution. The higher yield obtained when 4 t/ha was applied could be due to more leaves per plant that

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increased total fresh and dry weights of the plant.

The effect of sowing method was more pronounced at full vegetative stage as shown by significant response in plant height, number of leaves and leaf area at 6 WAS. Taller plant obtained in dibbled plots could be attributed to less competition and shattering effect among the crop, Likewise, more number leaves per plant obtained in drilled plot could be attributed to the higher plant population in the drilled plots. The non significant response of the yields due to the treatment effect might be attributed to the similar response in both sowing methods by yield attributes (number of leaves and leaves area). The interaction effect indicates that the crop performed best when 6 t/ha poultry was applied. This could be attributed to the fact that being a vegetable crop Roselle required nitrogenous fertilizer for its growth and development. This is supported by the appreciable quantity of nitrogen and other essential nutrients in the poultry manure used (Table 1). Similarly nitrogen level of the experimental site (Table 2) is less than the standard value of 1.50 g kg^{-1} (Anons, 1990), hence the need for appreciable quantity of applied nutrient to facilitate the growth and development of the plant. Similarly the taller plants with a larger leaf area in dibbled plot as obtained in the interaction showed that, the taller the plant the larger would be the leaf due exposure to sunlight and good aeration compared to closely spaced drilled plants.

CONCLUSION

Based on this investigation, it was observed that application of 4 t/ha poultry manure using dibbling or drilling sowing methods resulted in higher fresh and dry yields of roselle in Samaru under rain fed condition.

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Table 1: Physio-chemical properties of the soil of the experimental site during 2017 wet season at Samaru.

Physical properties (g/kg)	
Clay	80
Silt	420
Sand	500
Textural class	Loam
Chemical properties	
PH (H_2O) 1: 2.5	6.21
PH 0.01M $Cacl_2$	5.83
Total Nitrogen (g/kg)	0.60
Available p (g/kg)	74.1
Potassium (g/kg)	0.15
Exchangeable bases (cmol/kg)	
Calcium	2.60
Magnesium	0.401
Sodium	0.121
CEC	3.137

Soil sample analysed at the Department of Agronomy, Ahmadu Bello University, Zaria.

Table 2: Chemical composition of the poultry manure for the experiment during the 2017 wet season at Samaru.

Chemical composition (g/kg)	**Value**
Total Nitrogen	1.98
Available P	0.52
Potassium	0.21

Poultry manure sample analysed at Department of Agronomy, Ahmadu Bello University Zaria.

Table 3: Effect of poultry manure and sowing method on plant height during 2017 wet season at Samaru.

Treatment	**Weeks after sowing**			
	2 WAS	**4 WAS**	**6 WAS**	**8 WAS**
Poultry manure rate (P) (t/ha)				
0	8.87	17.23	36.13d	41.58b
2	8.93	19.73	37.87c	50.80ab
4	8.70	18.77	43.27b	60.30a
6	8.98	19.20	50.42a	57.17a
SE±	0.267	1.522	0.542	3.421
Sowing method (S)				
Dibbling	8.81	18.94	43.48a	52.47
Drilling	8.93	18.52	40.37b	52.26
SE±	0.187	1.085	0.541	2.423
Interaction (I)				
P x S	NS	NS	**	NS

Means followed by the same letter(s) in the same column within the same treatment group are statistically similar at P>0.05. Where NS= Not significant. WAS= Weeks after sowing.

Table 4: Table of interaction between poultry manure rate and sowing method on plant height at 6 WAS.

	Poultry manure rate (t/ha)			
Treatment	**0**	**2**	**4**	**6**
Sowing method				
Dibbling	36.63cd	37.63cd	42.77b	56.87a
Drilling	35.63d	38.16c	43.77b	43.97b
SE±	0.764			

Means followed by the same letter(s) within the same row or column are statistically similar at p≥0.05.

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Table 5: Effect of poultry manure and sowing method on plant number of leaves per plant during 2017 wet season at Samaru.

Treatment	Weeks after sowing			
	2 WAS	4 WAS	6 WAS	8 WAS
Poultry manure rate (P) (t/ha)				
0	4.73	16.50	32.26d	40.97c
2	4.98	19.53	39.33c	50.58b
4	4.73	19.26	46.13b	60.98a
6	4.80	19.47	53.70a	52.85ab
SE±	0.143	1.791	0.924	2.972
Sowing method (S)				
Dibbling	4.71	19.13	41.36b	50.23
Drilling	4.92	18.24	44.35a	50.47
SE±	0.106	1.273	0.654	2.101
Interaction (I)				
P x S	NS	NS	NS	NS

Means followed by the same letter(s) in the same column within the same treatment group are statistically similar at P>0.05. Where NS= Not significant, WAS= Weeks after sowing.

Table 6: Effect of poultry manure and sowing method on leaf area during 2017 wet season at Samaru.

Treatment	Weeks after sowing			
	2 WAS	4 WAS	6 WAS	8 WAS
Poultry manure rate (P) (t/ha)				
0	14.86	47.52b	119.10c	154.93b
2	17.37	71.70b	140.66b	198.86a
4	16.10	69.58a	77.03a	204.92a
6	16.30	74.43a	177.10a	206.67a
SE±	1.000	5.953	2.541	11.894
Sowing method (S)				
Dibbling	15.93	67.53	157.13a	188.57
Drilling	16.36	64.10	149.79b	194.12
SE±	0.711	4.204	1.802	8.400
Interaction				
P x S	**NS**	NS	**	NS

Means followed by the same letter(s) in the same column within the same treatment group are statistically similar at P>0.05. Where NS= Not significant. WAS= Weeks after sowing

Table 7: Interaction between poultry manure rate and sowing method on leaf area at 6 WAS.

	Poultry manure rate (t/ha)			
Treatment	**0**	**2**	**4**	**6**
Sowing method				
Dibbling	123.70cd	124.67c	185.67a	194.47a
Drilling	114.40d	186.65a	168.40b	159.73b
SE±	3.590			

Means followed by the same letter(s) within the same row or column are statistically similar at p≥0.05

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Table 8: Effect of poultry manure and sowing method on fresh leaves yield during 2017 rainy season at Samaru.

Treatment	Leaves fresh yield	Leaves dry yield
Poultry manure (P) (t/ha)		
0	1663.9b	186.57c
2	1941.2b	323.68b
4	2985.8a	426.65a
6	3256.2a	467.57a
SE±	115.02	19. 615
Sowing method (S)		
Dibbling	2468.3	354.51
Drilling	2455.3	347.73
SE±	81.33	13.870
Interaction		
P x S	NS	NS

Means followed by the same letter(s) in the same column within the same treatment group are statistically similar at P>0.05. Where NS= Not significant. WAS= Weeks after sowing.

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Effect of Different Organic Fertilizers on Yield and Quality of Amaranthus *(Amaranthus hybridus)*

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Abstract
Amaranthus hybridusis a vegetable with great nutritional value in human diet. Effects of different organic fertilizer rates was studied on plant height, number of leaves, leaf area, fresh and dry shoot weight, fresh and dry root weight, and proximate analysis were carried out using standard methods. The treatments consist of poultry manure (PM) at 100, 75, and 50%;cow dung used at 100, 75 and 50while control treatment contained no manure. The treatments were replicated 3 times and arranged in Completely Randomize Design (CRD). Data were collected on growth and yield parameters were analyzed with Analysis of variance and means were separated with Duncan Multiple Range Test. Results showed that different organic fertilizer rates had significant effect ($p\leq0.05$) on plant height, number of leaves, and leaf area with PM 100% had the tallest, more number of leaves and broadest leaf area (76.67cm, 12.33, and 1.572cm^3), respectively, while the shortest height, least number of leaves, and leaf area were obtained in the control. PM 100% had a significantly ($p\leq0.05$) higher amount of crude protein, crude fat, ash, vitamin A, Vitamin B_1, Calcium Ca, Potassium K, and Iron Fe, but control had the least. There was no significant effect($p\geq0.05$) of different organic fertilizer rate on chlorophyll content among the treatments except with control. PM 50% had the highest fresh and dry matter weight of (165195.87 and 20226.2 kg/ha), respectively, while PM 75% had the highest fresh and dry root weight of (99090.85 and 53651.9 kg/ha). In conclusion, different organic manure and their rate of application had a significant effect ($p\leq0.05$) on growth, yield and chemical composition of Amaranthus hybridus.
Keywords: Amaranthus hybridus,cow dung,organic manure, poultry manure, proximate analyses

INTRODUCTION

Amaranth (*Amaranth hybridus*) belongs to the family*Amaranthacea*which consists of about 60 species (Anjali *et al*., 2013). It is an important leafy vegetable of high dietary value and widely consumed in Nigeria (NIHORT, 1987). The cultivated forms are useful for producing nutritious grain and foliage and as colorful ornamentals (Brenner *et al*., 2000). Amaranths are heat and drought tolerant plants with most of the species monoecious, while some are dioecious. Amaranths received considerable attention in many countries because of the rich nutritional value of the

species with important source of food, as vegetable or grain (Srivastava, 2011). Its leaves constitutes a cheaper and rich source of protein, carotinoids (Shukla *et al*., 2010) and also very rich in minerals and vitamins (Muyonga*et al*., 2008) .

There has been an increase in demand for mineral fertilizers in the developing countries to boost crop yield due to an increase in population as a result of farmers yearning to meet the risen demand for agricultural products.The rising global population and changing eating habits are giving new prominence to agricultural challenges, such as the need to maintain and boost yields (Johannes, 2015). This made mineral fertilizers an important input in crop production inaccessible and expensive for farmers in the rural areas where major agricultural activities are carried out.

The use of organic fertilizers in crop production has been on an increase rate in recent times as substitute for costly and

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scarce mineral fertilizers. Organic fertilizers such as poultry manure, cow dung, compost, agro industrial wastes etc. have been recommended by researchers for use as substitute for mineral plant nutrient sources because they are less expensive, available and improve soil physical and chemical properties. Ogedegbe*et al.* (2015) recommended that amendment of top soil with animal fertilizers in a 1:1 ratio positively influenced growth and yield including some proximate components of amaranth varieties.This fact was in line with the conclusion of Oyedeji (2014) which stated that amaranthus species grown with NPK had higher protein, while those grown with poultry manure had higher ash content. Considering the impact of organic fertilizers on crop quality, it is also important to examine the extent of this effect amongdifferent organic fertilizers, due to their differences in quality (nutrients composition) (Moyin-Jesu, 2008) which depend greatly on types of animal and the quality of feed they feed on.The objectives of this study are: to determine and compare the effect of different rates of organic fertilizers on growth and yield of *Amaranthus hybrisdus* and to determine and compare the effect of the different rates of organic fertilizers on the quality of *Amaranthus hybridus*.

MATERIALS AND METHODS

The experiment was carried out at Bore Farm of the Federal College of Agriculture, Moor Plantation, Ibadan, Oyo State, Nigeria between March and May 2018. Moor Plantation, Ibadan is situated onLatitude 7^0 23' N and Longitude 3^0 50' E. The pre cropping soil analysis presented in Table 1 showed that the soil is loamy soil in texture. The pH of the soil (5.6) was slightly acidic. The total Nitrogen (1.2g/kg) and organic carbon (15.5g/kg), Phosphorus (10 mg/kg) and Potassium (0.2cmol/kg) in the soil were low. Obviously, the soil used is deficient in some essential nutrients and requires fertilizer amendment. This implies that the soil is having low fertility status, thus the soil is good for a fertilizer trial.Nursery bed was preparedand seed was sown at 1:3 ratio of seed mixed with soil. Wetting was done twice a day until seedlings were transplanted into perforated polythene bags filled with 2kg topsoil, premixed with poultry manure and cow dung at different rates of 50%, 75%, and 100% 2weeks before sowing to allow mineralization of the organic materials. The experiment consist of sixtreatments and a control (poultry manure 100%, poultry manure 75%, poultry manure 50%, cow dung 100%, cow dung 75%, cow dung 50%, and control) replicatedthree times andarranged in completely randomize design (CRD).The treatment were arranged as follows: Poultry manure 100% (T_1), Poultry manure 75% (T_2), Poultry manure 50% (T_3), Cow dung 100% (T_4), Cow dung 75% (T_5), Cow dung 50% (T_6), and Control (T_7). Transplanting of seedlings was done 2 weeks after sowing (WAS), hand weeding and watering at regular intervals. Data were taken on the growth parameters of the plant such as plant height, leaf area, and stem girth at 2weeks interval, while fresh and dry shoot weight and root weight were taken at harvest period. Destructive samples were harvested at 100% flowering and taken to the laboratory for nutrient analysis. Other inflorescences was harvested when the inflorescence have matured in each plot, threshed and winnowed manually to recover the grains. Grains collected were weighed per plot using electric weighing balance (model BP 210S).Data collected were subjected to analysis of variance (ANOVA) while treatment means were compared using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Effect of Different Organic Manureon Plant Height (cm): Different organic

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manurerates had a significant effect ($P \leq 0.05$) on the plant height at 2 weeks after sowing(Table 2). Treatment consisting of Poultry Manure (100%) had the tallest plant height (23.67cm), while treatment consisting of Cow Dung at 50% had shortest plant height of (18.00cm) which is not significantly ($P \geq 0.05$) different from treatment T_5 and T_7. There was also a significant effect ($P \leq 0.05$) of different organic manure on plant height at 4 weeks after sowing with Poultry Manure (100%)having the tallest plant height (36.67cm), while the shortest height (20.33cm) was obtained in control. Similarly, at 6 weeks after sowing, the different organic manure effect had significant ($P \leq 0.05$) on plant height. The tallest plant height (76.67cm) was obtained with Poultry Manure (100%), though, not significantly different ($P \geq 0.05$) from Poultry Manure used at75%, while the shortest plant height was recorded in control.

Effect of Different Organic Manure on Number of Leaves: Effect of different organic manureon number of leaves of amaranth was significant ($P \leq 0.05$) at 2 weeks, 4 weeks and 6 weeks after sowing as shown in Table 3. Plants in Poultry Manure (100%) had more numbers of leaves of (7.33, 9.00 and 12.33) at 2, 4 and 6 weeks after sowing, respectively, while Control recorded the fewest numbers of leaves (3.67) at 2 weeks after sowing although, this was not significantlydifferent ($P \geq 0.05$) from what was obtained in Cow Dung 100%, 75% and 50%. Control treatment also recorded the fewest number of (5.67 and 6.00) leaves at 4 and 6 weeks after sowing, respectively, though, number of leaves recorded in control treatment at week 4 was not significantly different ($P \geq 0.05$) from other treatments except Poultry Manure (100%) but significantly different ($P \leq 0.05$) at week 6 from Poultry Manure 100%, 75% and 50%.

Effect of Different Organic Manure on Leaf Area: Different organic manure had a significant effect ($P \leq 0.05$) on amaranths leaf area as revealed in Table 4. The widest leaf area of (16.42cm^2) was obtained in Cow Dung (50%) which was not significantly different ($P \geq 0.05$) from other treatments except that of control and the least (8.97cm^2) recorded in control at 2WAS.There was also a significant effect ($P \leq 0.05$) of different organic manure on the leaf area of amaranths at 4WAS with plant in treatment consisting of Cow Dung (100%) recorded the broadest leaf area (45.26 cm^2) and the least (13.67cm^2) obtained in control. At 6WAS, different organic manure had a significant effect ($P \leq 0.05$) on the amaranths leaf area, the widest leaf areaof (157.20cm^2)was recorded in Poultry Manure (100%) which was significantly different ($P \leq 0.05$)vis-à-vis other treatments except Poultry Manure (75%)while the least (30.15cm^2) was obtained in controlwhich was not significantly different from treatment with Cow Dung (50%).

Proximate Analysis of *Amaranthus hybridus:* The effect of different organic manure on nutritional and mineral composition of amaranths in Table 5 showed a significant effect ($P \leq 0.05$) in the chlorophyll content with the highest chlorophyll content recorded in treatment consist of Poultry Manure (75%), though not significantly different ($P \leq 0.05$) form other treatments except control (no treatment) which gave the least chlorophyll content of (27.85). Different organic manure had a significant effect ($P \leq 0.05$) on crude protein content of amaranths showed in Table 5.The highest crud protein content (12.82) was recorded in treatment containing Poultry Manure (100%) which is significantly different ($P \leq 0.05$) from other treatments except treatment consist of Cow Dung (75%), however, the least crud protein content (4.13) was recorded in control (no

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treatment).Effect of different organic manure was significant (P≤0.05) on crude fiber as recorded in Table 5. The fiber content was highest (7.86) in treatment containing Cow Dung (75%) which is significantly differentfrom other treatments while the least fiber content (4.15) was obtained in control (no treatment). Significant differences (P≤0.05) were noticed on fat content among the treatments showed in Table 5. The highest fat content (0.40) was recorded in Poultry Manure (100%) which is significantly different (P≤0.05) from other treatments except treatment which contain Poultry Manure (75%), while the least fat content (0.28) obtained in control though not significantly different from what was obtained in Cow Dung (50%) as showed in Table 5.

Influence of difference organic manure on ash content of amaranths was significant (P≤0.05)(Table 5)The highest ash content (3.8) was recorded in treatment containing poultry Manure (100%) and this was significantly different (P≤0.05) from what was obtained in other treatments, however, the least ash content (2.41) was obtained in control.Different organic manure effect on amaranths moisture content was significant (P≤0.05) among the various treatments as showed in Table 5. The highest moisturecontent of (86.97) was obtained in treatment containing Poultry Manure (100%) though not significantly different from results obtained in Poultry Manure (75%) and Cow Dung (100%) however, the least moisture content(83.31) was obtained in control which is not significantly different from Cow Dung (75% and 50%).

Different organic manure showed a significant effect on mineral content of amaranths as showed in Table 5. The highest calcium (Ca) content (227.74) was recorded in Poultry Manure (100%)while the least calcium (Ca) content of (183.78) was recorded in control. The case was the same with potassium (K) on which the effect of different organic manure was significant (P≤0.05), the highest potassium (K) content (624.37) was recorded in Poultry Manure (100%) while the least (440.43) recorded in control. On phosphorus content, effect of different organic manure was significant (P≤0.05), the highest phosphorus (P) content (50.80) was recorded in Poultry Manure (100%) which is significantly different from other treatments while the least phosphorus (P) content (38.14) was obtained in control. The iron (Fe) content was also affected by different organic manure, the highest iron (Fe) content (2.09) was obtained in Poultry Manure (100%) and this is significantly different from other treatments however, the least iron (Fe) content (1.47) was recorded in control.

Influence of different organic manure on the amount of vitamin present in amaranths was significant (P≤0.05) among the treatments. The largest Vitamin A content (0.32) was recorded in Poultry Manure (100% and 75%) and are significantly different (P≤0.05) from other treatments while the least Vitamin A content (0.27) was recorded in control. For Vitamin B_1, the highest value of (0.04) was recorded in Poultry Manure (100%, 75%, 50% and Cow dung 100%) which are significantly different (P≤0.05) from other treatments while the least Vitamin B_1 content (0.02) was obtained in control. There was also a significant effect (P≤0.05) on Vitamin B_2 content with the highest amount (0.16) recorded in Poultry Manure (100%) which is significantly different (P≤0.05) from other treatments, while the least was Vitamin B_2 content (0.14) recorded in (Cow Dung 50% and control). Poultry Manure (100%) gave the highest amount of Vitamin B_3 which is not significantly different (P≤0.05) from other treatments except Cow Dung (50%) and control while the least Vitamin B_3 content (0.08) obtained in control.Similarly, the

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effect was also significant on Vitamin C with the highest Vitamin C content (48.07) obtained in Poultry Manure (100%)which is significantly different from other treatments while the least of (37.11) recorded in control.

Effect of Different Organic Wet and Dry Shoot and Root Weight Content: The effect of different organic manure on fresh and dry weight of Amaranth shoot and root was significant (P≤0.05) among the treatments as shown in Table 6. The highest fresh and dry shoot weight was obtained in Poultry Manure 100% while the lowest weight was recorded in control treatment. Similarly the highest fresh and dry root weight was obtained in Poultry Manure 100% while least was obtained in Cow Dung 50% although, not significantly different (P≥0.05) from treatments with Poultry Manure 50%, Cow Dung 75%, and control.

Different organic manure had a significant (P≤0.05) effect on fresh and dry weight of shoot and root of *Amaranthus hybridus*. Quantitatively, the highest fresh shoot weight (123.90kg/ha) was obtained in Poultry Manure (100%) which was significantly different (P≤0.05) from other treatments, while the lowest weight (9.20kg/ha) was recorded in control. Similarly, Poultry Manure (100%) recorded the highest dry shoot content (15.17kg/ha)which was significantly different (P≤0.05) from what was obtained in other treatments while the least (1.9kg/ha) was obtained in the control. There were significant differences (P≤0.05) among the treatments on the effect of different organic manure on fresh and dry root weight. The highest fresh root weight (74.32kg/ha) was recorded in Poultry manure (100%) and this was significantly different (P≤0.05) from other treatments while the least was recorded in Cow Dung (50%). The trendwas the same for dry root weight, the highest (40.24kg/ha) was recorded in Poultry Manure and was significantly different from other treatments and the least obtained in Cow Dung (50%).

DISCUSSION

The results of the study showed that different organic manure rates are capable of improving the quality and yield of *Amaranthus hybridus.* The differences were not significant among the rates of each of the manure but significant among the different manure used in most of the parameters considered. The observed differences in values obtained in all the growth parameters assessed could be attributed to differences in nutrient contained in each of the manure which depend majorly on type of animal and the quality of feed on which they feed. This agreed with the report of Ewulo (2005) which stated that varied chemical concentration were observed in soil amendment when manure from different source were used, the report confirmed an increased in soil pH, O, C, N, P, K, Ca, Mg, Mg, Na and CEC with rate of manure in soil amended with poultry and cattle manure and poultry manure gave quick response and higher concentration of soil chemical properties. The observed improvement in all the parameters assessed could be attributed to the ability of poultry manure to increase soil organic matter content the store of plant nutrients, stimulate the activities of soil organism, which aid the release of nutrient needed by the crop plant; these might have contributed to the improvement of the parameters considered (Okoli and Nweke, 2015).The study also revealed that poultry manureproduced higher effects on proximate, mineral, vitamin A, B, and C composition of *Amaranthus hybridus*than cow dung in all the parameters investigated. The results of the study are in agreement with Arisha*et al.*(2003), Makinde*et al.* (2010), Shaheen*et al.*(2007) whose reports confirmed an improvement on some proximate and mineral contents

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of crop in organic manures than inorganic fertilizers, attributing the factors influencing the disparities to leaching through which nutrients in mineral fertilizers are lost while in organic manures are not readily available but have to undergo decomposition and mineralization (Makinde*et al.,* 2010). Organic manures activate many species of living organisms which release phytohormones and may stimulate plant growth and nutrients (Arisha*et al.,* 2003). The results also validate (Katherine *et al.,* 2007) which showed that organic is more nutritious than non-organic food and may lengthen people's lifespan. The report also confirmed that such food contains higher level of antioxidants and flavonoid as well as iron and zincwhich protect the heart and protect against diseases andcancer.

A sharp increase in demand for vegetables witnessed globally is attributed not only to preference but also for nutritional benefits derived from them. Higher amount of nutrients recorded in poultry manure in this study gives preference to the use of poultry manure than cow dung. The results therefore, encourage the use of poultry manure in growing *Amaranthus hybridus*for better nutritional quality.In conclusion: Although, there were some significant differences among all the treatment in terms of amaranths leaf area, plant height and number of leaves, poultry manure is better than cow dung and control. Also in terms of shelf life, poultry manure has better storage life than that of cow dung. Poultry manure also contributed to the fertility of the soil because it added to the nutrient property of the soil while plant also took some nutrient in the soil.

RECOMMENDATION

It was shown that both 100% and 75% of poultry manure gave the highest yield. In terms of shelf life, poultry manure also performed well in terms of nutritional value of *Amaranthus hybridus* that the body will require. *Amaranthus hybridus* production should be encouraged among the farmers because of its chemical composition and nutritional status. The use of organic fertilizer should not be discouraged among the farmers because according to researchers it was confirmed these poultry manure have side effect to our body. It was observed that 100% and 75% of poultry manure should be used by the farmers for polythene bag plant as it increased the yield of the vegetable, had a high nutritional and also increase soil physical and chemical properties. However, further studies will be required by widening the range of the level of poultry manure used in other to investigate a possible significant difference among the different levels of application.

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Table 1: Physical and chemical properties of the experimental soil

Soil parameter	Soil test value
pH	5.6
Total N (g/kg)	1.2
Organic Carbon (g/kg)	15.2
Available phosphorus (mg/kg)	10
Exchangeable Bases (C mol/kg)	
Ca+	0.7
Mg+	0.9
K+	0.1
Na+	0.2
Particle Size Distribution (g/kg)	
Sand	860
Clay	72
Silt	68
Textural class	Loamy Sand

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Table 2:Effect of different organic manure on plant height (cm)

Treatments	2 WAS	4 WAS	6 WAS
T_1	23.67^{a}	36.67^{a}	76.67^{ab}
T_2	22.67^{ab}	32.00^{ab}	73.33^{ab}
T_3	21.00^{bc}	30.33^{ab}	62.67^{bc}
T_4	21.00^{bc}	30.00^{ab}	60.33^{c}
T_5	19.33^{cd}	29.67^{b}	52.67^{c}
T_6	18.00^{d}	29.33^{b}	38.33^{d}
T_7	19.67^{cd}	20.33^{c}	36.67^{d}

Means with same letter (s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT).Poultry manure 100% (T_1), Poultry manure 75% (T_2), Poultry manure 50% (T_3), Cow dung 100% (T_4), Cow dung 75% (T_5), Cow dung 50% (T_6), and Control (T_7)

Table 3: Effect of different organic fertilizer on number of leaves (cm)

Treatments	2 WAS	4 WAS	6 WAS
T_1	7.33^{a}	9.00^{a}	12.33^{a}
T_2	5.33^{b}	7.00^{b}	9.67^{b}
T_3	5.00^{b}	6.67^{b}	9.33^{b}
T_4	4.67^{bc}	6.33^{b}	8.00^{bc}
T_5	4.33^{bc}	6.33^{b}	7.67^{bc}
T_6	4.33^{bc}	6.00^{b}	6.67^{c}
T_7	3.67^{c}	5.67^{b}	6.00^{c}

Means with same letter (s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT).Poultry manure 100% (T_1), Poultry manure 75% (T_2), Poultry manure 50% (T_3), Cow dung 100% (T_4), Cow dung 75% (T_5), Cow dung 50% (T_6), and Control (T_7)

Table 4: Effect of different organic manure on leaf area (cm^2)

Treatments	2 WAS	4 WAS	6 WAS
T_1	14.28^{ab}	34.18^{b}	157.20^{a}
T_2	11.33^{ab}	33.93^{b}	121.30^{ab}
T_3	11.87^{ab}	20.58^{c}	83.50^{bc}
T_4	13.68^{ab}	45.26^{a}	85.58^{bc}
T_5	10.09^{ab}	26.91^{c}	85.08^{bc}
T_6	16.42^{a}	33.78^{b}	60.59^{cd}
T_7	8.97^{b}	13.67^{d}	30.15^{d}

Means with same letter (s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT).
Poultry manure 100% (T_1), Poultry manure 75% (T_2), Poultry manure 50% (T_3), Cow dung 100% (T_4), Cow dung 75% (T_5), Cow dung 50% (T_6), and Control (T_7)

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Table 5:Proximate analysis on different organic manure on*Amaranthus hybridus*

Treatment	Chlorophyll	Crude Protein	Crude Fiber	Fat	Ash Content	Moisture Content	Ca mg/100g	K m/100g	P m/100g	Fe m/100g	Vitamin A mg/100g	Vitamin B1 mg/100g	Vitamin B2 mg/100g	Vitamin B3 mg/100g	Vitamin C mg/100g
T_1	35.31^{a}	12.82^{a}	7.86^{a}	0.40^{a}	3.80^{a}	86.97^{a}	227.74^{a}	624.37^{a}	50.80^{a}	2.09^{a}	0.32^{a}	0.04^{a}	0.16^{a}	1.19ab	48.07a
T_2	38.29^{a}	12.71^{a}	7.42^{b}	0.38^{a}	3.76^{b}	86.33^{ab}	224.56^{b}	623.16^{a}	49.74^{b}	1.94^{b}	0.32^{a}	0.04^{a}	0.15^{b}	1.15ab	44.84b
T_3	35.98^{a}	11.44^{b}	6.52^{c}	0.36^{b}	3.42^{d}	85.23^{bc}	216.34^{cd}	617.35^{b}	45.96^{d}	1.86^{c}	0.31^{b}	0.04^{a}	0.15^{b}	1.15ab	42.80c
T_4	37.86^{a}	11.42^{b}	6.18^{d}	0.33^{c}	3.48^{c}	86.01^{ab}	217.93^{c}	618.51^{b}	46.76^{c}	1.79^{d}	0.30^{c}	0.04^{a}	0.15^{b}	1.14ab	44.98b
T_5	36.83^{a}	11.24^{b}	6.17^{d}	0.33^{c}	3.25^{e}	83.77^{cd}	214.31^{d}	619.52^{b}	42.67^{e}	1.68^{e}	0.29^{d}	0.03^{b}	0.15^{b}	1.13ab	44.49b
T_6	39.39^{a}	7.42^{c}	5.85^{e}	0.28^{d}	3.17^{f}	83.83^{cd}	211.04^{e}	593.32^{c}	41.59^{f}	1.63^{e}	0.29^{d}	0.03^{b}	0.14^{c}	1.12b	44.65b
T_7	27.85^{b}	4.13^{d}	4.13^{f}	0.29^{d}	2.41^{g}	83.31^{d}	183.78^{f}	440.43^{d}	38.14^{g}	1.47^{f}	0.27^{f}	0.02^{c}	0.14^{c}	0.81c	37.11d

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Table 6:Effect of different organic manure on fresh and dry weight ofshoot and root of *Amaranthus hybridus* (kg/ha)

Treatments	Wet Shoot Content	Dry Shoot Content	Wet Root Content	Dry Root Content
T_1	123.90[a]	15.17[a]	74.32[a]	40.24[a]
T_2	68.22[c]	9.8[b]	38.2[b]	22.73[b]
T_3	60.59[d]	7.4[cd]	19.0[d]	4.75[d]
T_4	83.28[b]	4.65[d]	28.76[c]	18.9[c]
T_5	43.31[e]	4.75[d]	14.84[e]	8.78[cd]
T_6	73.37[c]	8.4[c]	10.9[g]	4.23[d]
T_7	9.20[f]	1.9[e]	11.03[f]	7.28[cd]

Means with same letter (s) in a column are not significantly different at 5% level of probability by Duncan Multiple Range Test (DMRT).
Poultry manure 100% (T_1), Poultry manure 75% (T_2), Poultry manure 50% (T_3), Cow dung 100% (T_4), Cow dung 75% (T_5), Cow dung 50% (T_6), and Control (T_7)

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Effect of Irrigation Interval on Growth and Yield of Kenaf (*Hibiscus cannabinus* L.) in Samaru, Zaria

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Abstract
An experiment was conducted during the 2016/2017 dry season at the Horticultural Unit of Samaru College of Agriculture, Ahmadu Bello University, Zaria in the Northern Guinea Savanna to determine the effect of irrigation interval on growth and yield of kenaf (Hibiscus cannabinus L.) in Samaru, Zaria. Treatments consisted of five irrigation intervals (2, 4, 6, 8 and 10 days) laid out in a completely randomized design (CRD) replicated four times in polythene bags. Data were collected on plant height, number of leaves plant^{-1}, leaf area plant^{-1}, total dry matter plant^{-1}, fibre yield plant^{-1} and fibre yield ha^{-1}. All data collected was analyzed statistically and treatments means were compared using least significant difference (LSD) at 5% level of probability. The effect of irrigation interval on the growth and yield of kenaf were significant on plant height, number of leaves plant^{-1}, leaf area plant^{-1}, total dry matter plant^{-1}, fibre yield plant^{-1} and fibre yield ha^{-1}. 2 days irrigation interval significantly produced higher means, while 10 days irrigation interval produced significantly lower means on similar characters.
Keywords: *Kenaf, irrigation, interval, growth and Yield*

INTRODUCTION

Kenaf (*Hibiscus cannabinus* L.) also called Bimly, Bimlipatum, Jute and Deccan Hemp is a member of the Hibiscus family (*Malvaceae*) and indigenous to Africa. It is an annual fibre crop (Alexopoulou *et al.*, 2000). The name kenaf is of Persian origin and is used to signify both the tall annual plant (*Hibiscus cannabinus* L.) with large flowers, characteristic of the Mallow family, and the bast fibre obtained from its stem (Angelini *at al.*, 1998). The genus Hibiscus is widespread, comprising of some 200 annual and perennial species. Francis *et al.* (2010) reported that kenaf is closely related to cotton (*Gossypium hirsutum* L.) and okra (*Hibiscus esculentus* L.). Manzanares *et al*. (1997) reported that kenaf is one of the important fibre crops next to cotton and is cultivated for its core and bast fibres. Recently, the interest in growing kenaf has been increasing throughout the world for its elevated fibre content (Alexopoulou *et al.*, 2000). It is a fast growing crop and has high potential as an industrial crop (Manzanares *et al.*, 1997). The residual core fraction is used as biomass for energy production (Danalatos and Archontoulis, 2005). Kenaf is traditionally grown in east-central Africa, west Asia and in several southern states of America for fibre and seed oil production. It is also an excellent forage crop (Muchow and Wood, 1980), containing 18-30% crude leaf protein and stalk protein 5.8-12.1% (Ogbonnaya *et al.*, 1997).

Water deficit is known to retard plant growth and reduce yield but is not always injurious, because it has been reported to improve the quality of some plant products (Taylor, 1992; Enukwesi *et al*., 1986). Water is the most important limiting factor for crop production in arid and semi-arid regions. It should be used more efficiently in irrigated agriculture to increase and sustain productivity. In crop production, instead of reaching maximum yield per unit area by full irrigation, water productivity can be optimized within the concept of deficit irrigation (White *et al.*, 1970; Enukwesi *et al*., 1986). Identifying a relationship between water use efficiency and seed yield under deficit irrigation has been a major concern of agricultural

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research in semi-arid regions (White *et al*., 1994). The greatest challenge for agriculture is to develop agronomic options to improve water use efficiency. White *et al.* (1994) studied the effect of water stress on kenaf and found that although water deficit reduced volume of wood produced, the quality of pulp and paper produced were not significantly affected.

Uncontrolled water application to crops has consequences. It encourages leaching of available nutrients away from crops' root zone, reduces range of crops to be grown and affects sustainability of farming system. Therefore, proper utilization of irrigation water in Kenaf production would increase yield and quality. The objective of the study is to determine the effect of irrigation interval on the growth and yield of Kenaf in Samaru, Zaria. Scanty information on the effect of drought on Kenaf is documented. In view of this, the present study was carried out to determine the effect of irrigation interval on the performance of Kenaf in Samaru, Zaria.

MATERIALS AND METHODS

The experiment was conducted in the Greenhouse of Horticultural section of Samaru College of Agriculture, Ahmadu Bello University, Zaria between November 2016 – May 2017. Samaru (latitude $11^0$11`N; longitude $07^0$38`E and altitude 686m above sea level) is located in the Northern Guinea Savanna Zone of Nigeria. The area is tropical with wet and dry climate; mean annual temperature and rainfall of 29^0C and 900 mm-1000 mm, respectively (Field Survey, 2016). The experimental design used was completely randomized design (CRD) consisting of five irrigation intervals (2, 4, 6, 8 and 10 days interval) replicated four times to give 20 polythene bags filled with a top soil and kept in greenhouse throughout period of experiment. Three seeds were sown in each polythene bag and later thinned to two seedlings (polythene bag)$^{-1}$ or per polythene bag during the first weeding, three weeks after sowing. All recommended agronomic practices were followed. Data were collected on plant height (cm), number of leaves plant^{-1}, leaf area (cm^2) plant^{-1}, total dry matter plant^{-1}, fibre yield plant^{-1} (gm), fibre yield ha^{-1} (kg) and analyzed statistically using mixed model procedure of statistical analysis system (SAS) software version 8. Means were separated using the least significant difference (LSD) at 5% level of probability (Rangaswamy, 2010).

RESULTS

Table 1 shows physical and chemical properties of the soil used for the trial during the 2016/2017 dry season. The soil of experiment contained a higher proportion of sand (84.42%), low silt (6.75%), low clay (10.12%) and low organic carbon (4.92%). The chemical analysis also showed that pH in water was (6.30%), total nitrogen was low (4.00%), low available phosphorus (2.40 mg kg^{-1}), low available potassium (1.73 mg kg^{-1}), low available calcium (0.64 mg kg^{-1}), low available sodium (0.58 mg kg^{-1}), low available magnesium (1.37 mg kg^{-1}) and low cation exchange capacity (5.28 mg kg^{-1}).

Table 2 shows treatment variations on plant height, number of leaves and leaf area per plant of kenaf. Plant height was significantly influenced ($P<0.05$) by irrigation interval. The 10 day irrigation interval produced shorter plants which were at par with 8 day irrigation interval while 2 day irrigation interval recorded the highest mean value among which was also similar to 4 day frequency. Irrigation interval was also significant on number of leaves plant^{-1}. Increasing the irrigation

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interval from 2 to 10 day intervals significantly reduced the number of leaves per plant. Similar trend was observed on leaf area plant^{-1}.

Irrigating every 10 days produced the least mean leaf area but similar to 8-day irrigation. This was followed by 6 days irrigation interval which was at par with 4 and 8 days irrigation. The 2 day irrigation interval significantly gave the highest mean leaf area per kenaf plant.

Total dry matter (gm) plant^{-1}

Table 2 shows that there was a significant difference ($P<0.05$) among the means due to irrigation interval on total dry matter plant^{-1}. 10 days irrigation interval produced the lowest mean, which was followed by 8 days irrigation interval, followed by 6 days irrigation interval, followed by 4 days irrigation interval and finally 2 days irrigation interval significantly gave the highest mean value among the irrigation interval.

Fibre yield (gm) plant^{-1}

Table 2 shows that there was a significant difference ($P<0.05$) among the means due to irrigation interval on fibre yield plant^{-1}. 10 days irrigation interval produced the lowest mean, which was followed by 8 days irrigation interval, followed by 6 days irrigation interval, followed by 4 days irrigation interval and finally 2 days irrigation interval significantly gave the highest mean value among the irrigation interval.

Fibre yield (kg) ha^{-1}

Table 2 shows that there was a significant difference ($P<0.05$) among the means due to irrigation interval on fibre yield ha^{-1}. 10 days irrigation interval produced the lowest mean, which was followed by 8 days irrigation interval, followed by 6 days irrigation interval, followed by 4 days irrigation interval and finally 2 days irrigation interval significantly gave the highest mean value among the irrigation interval.

DISCUSSION

In general, the differences among the mean values of all the studied growth characters as affected by irrigation intervals were found to be significant (Table 2). The highest mean values on plant height, number of leaves plant^{-1}, leaf area plant^{-1} were obtained using irrigation interval of every two days, compared with the other irrigation interval treatments in 2016/2017 dry season. These results illustrate generally that increasing irrigation interval every two days was associated with corresponding decrease in the mean values of such characters. Such results may be due to the water functions in plant growth since the irrigated water is a major constituent of physiologically active tissues and a solvent in which salts, sugars and other solutes move from cell to cell and organ to organ which is essential for the maintenance of the turgidity necessary for cell enlargement and growth, consequently dry matter and growth characters. On the other hand, applying irrigation water 8 or 10 days interval gave the lowest mean values of all the studied vegetative growth and yield characters in 2016/2017 dry season. Such results can be discussed on the basis that when plants are exposed to a prolonged period of water deficit, vegetative growth characters are seriously decreased through decreasing their growing organs. These results are in agreement with those obtained by Ulas *et al.* (2011) on eggplant; El-Afifi *et al.* (2013); Habib *et al.* (2012); Mohawesh (2016); Yesim *et al.* (2015); Gwandu and Idris (2016) on onion. Regarding the effect of irrigation interval on yield parameters of kenaf, data in Table 3 clearly show that the highest significant values of the studied yield parameters were recorded at 2 days irrigation interval during the period under review. It could be stated that increased frequency of water applied to plants led to higher moisture content in the soil and this in turn increased plant metabolism that led to increase in yield

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characters. This observation is in agreement with those of Ulas *et al.* (2011); El-Afifi *et al*. (2013); Habib *et al.* (2012); Mohawesh (2016); Yesim *et al.* (2015); Gwandu and Idris (2016) on onion. They equally reported that reducing the irrigation interval from 10 days to 2 days led to significant increase in the total dry matter plant^{-1}, fibre yield plant^{-1} and fibre yield ha^{-1}. On the other hand, increasing the irrigation interval from 2 days to 10 days led to significant decrease in the same characters assessed.

CONCLUSION

The 2- day irrigation interval produced highest mean values of plant height, number of leaves plant^{-1}, leaf area plant^{-1}, total dry matter, fibre yield per plant and total fibre yield followed by 4 - day irrigation interval while 10 – day irrigation interval produced the least.

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Table 1: Physical and Chemical Properties of the Soil Used for the Experiment in 2016/2017 Dry Season.

Mechanical composition	Soil depth 0-30 cm
Sand %	84.42
Silt%	6.75
Clay%	10.12
Organic carbon%	4.92
PH in H_20	6.30
Total nitrogen %	4.00
Available phosphorus mg kg^{-1}	2.40
Available potassium mg kg^{-1}	1.73
Available calcium mg kg^{-1}	0.64
Available sodium mg kg^{-1}	0.58
Available magnesium mg kg^{-1}	1.37
Cation exchange capacity (CEC) mg kg^{-1}	5.28

Table 2: Effect of Irrigation Interval on growth parameters of kenaf at Samaru in 2016/2017 Dry Season

Effect of Irrigation Interval	Plant height (cm) $plant^{-1}$	Number of leaves $plant^{-1}$	Leaf area (cm^2) $plant^{-1}$	Total dry matter $plant^{-1}$ (gm)	Fibre yield $plant^{-1}$ (gm)	Fibre yield ha^{-1} (kg)
2 days irrigation interval	54.46a	22.55a	55.34a	60.45a	45.66a	3,634.26a
4 days irrigation interval	51.77ab	18.86b	52.32ab	57.28ab	43.87ab	3,411.78b
6 days irrigation interval	48.84b	16.47c	49.14b	54.73b	41.48b	3,344.81bc
8 days irrigation interval	45.43bc	14.60c	47.22bc	52.18b	39.64bc	3,264.76c
10 days irrigation interval	42.36c	12.16d	45.28c	48.28c	37.42c	3,024.92d
LSD	3.24	2.15	3.35	3.62	2.67	126.99

Means followed by same letter(s) in the same column are not different statistically at *P=0.05* using least significant difference.

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Consumers' Awareness of the Medicinal Potentials of Onion and Garlic (*Allium* spp.) among Rural Households in Imo State, Nigeria

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Abstract
The long-term micronutrient malnutrition problem of the rural populace cannot be solved by food aid or food trade alone but rather by the adequate utilization of indigenous plant foods such as spices. This study was aimed at assessing the consumers' awareness of the medicinal potentials of two Allium spp. (Onion and garlic) among rural households in Imo State, Nigeria. Data for the study were obtained from one hundred and forty (140) respondents made up of mostly farmers in four (4) Local Government Areas (LGAs) in the state namely; Nwangele, Orlu, Isi-ala mbano and Okigwe LGAs respectively using a well-structured questionnaire as interview schedule. Data were analysed using simple descriptive statistics, cross tabular analysis and probit regression estimates. Results showed that more than half of the respondents (55.7%) were males and 47.1% were in the age bracket of 22-45 years. The study also revealed that 48.6% of the respondents had an average household size of 1-6 people while about a half (50.7%) of the respondents had primary level of education. The general health perception about onions when cross-tabbed with the period of consumption by respondents revealed the highest score (27.1%) in the "very good" category among those who had been consuming onions for 21-45 years on average, whereas for garlic, the highest perception score (27.1%) was found in the "poor" category amongst those who had been consuming the spice for a period of 21-45 years. The probit regression result showed that age, work experience and household income were the socio-economic factors influencing the health awareness of Allium spp. in the study area. It is however recommended that more awareness on the medicinal potentials of garlic as a spice be heralded by agricultural extension officers via seminars, field visits and radio jingles in order to boost its consumption viz-a-viz it's marketability in the study area.
Keywords: Allium spp.*, Consumer awareness, rural households, Health perception and probit regression*

INTRODUCTION

Spices have micronutrient and antioxidant potentials of which their consumption in whole or in use as condiments can be a means of dietary diversity in ameliorating micronutrient deficiencies (Oladejo and Oladele, 2013). *Allium* spp. (onion and garlic) are spice plants of high value economically, nutritionally and medicinally that offer significant portions of micronutrients (potassium, iron, magnesium, calcium and sulphur) to the diet and therefore essential for the general well-being of humans. Onion (*Allium cepa L.*) is a natural part of the daily diet for most of the world's population (Mogren *et al*., 2008; Sohail *et al*., 2011). The World Health Organization (WHO) supports the use of onions for the treatment of poor appetite and to prevent atherosclerosis. It is widely cultivated second only to tomato and is a vegetable bulb known to most cultures and consumed worldwide (FAO, 2012). In addition, onion extracts are recognized by W.H.O for providing relief in the treatment of coughs and colds, asthma and bronchitis.

Garlic (*Allium sativum* L.) doubles as a laxatic plant and a functional food. A food that has components or ingredients that provide a potential benefit to health, well-being, physical fitness, or disease resistance above and beyond the benefit expected from its main nutritional components of carbohydrates, lipids, proteins, minerals, and vitamins are referred to as functional food (Fasoyiro, 2015). It is widely used around the world for its pungent flavor as a seasoning or condiment. *Allium sativum L.* is

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nutritionally complete in that it contains numerous mineral substances and trace elements (Mg, S, K, Zn, & Fe) that keep the human body healthy and resistant to diseases (Borek, 2006). This spice has been discovered as one of the most powerful medicinal plants for combating high blood pressure, protecting the heart and promoting blood circulation (Fuster and Kelly, 2010). It is also effective in regulating blood sugar levels and improves libido.

Most spices have been relegated to the background despite their huge potentials for health and wellness. Also, the wide acceptance and utilization of synthetic flavours which puts a consumer at a higher risk for health related issues is fast gaining ground over the use of natural plant products either through cultural, religious and economic differences. Encouraging consumers to use spices and herbs when cooking, for example, can help reduce the intake of less desirable foods and nutrients, particularly salt, solid fats, and sugar, while increasing the intake of vegetables and other high-fiber foods (Dwyer, 2014).

Health conscious consumers in developed countries prefer natural colours and flavours of plant origin to cheap synthetic ones which inadvertently makes spices one of the basic building blocks of flavor in food applications. A small number of consumers rank spices and herbs among the top foods with benefits beyond basic nutrition, but many others do not perceive the added health benefits of spices and herbs (International Food Information Council, 2011)

While most studies on onion and garlic have been mostly on their exciting flavors and aromas, medicinal values and as flavoring agents, little or no effort have been devoted to consumer awareness on the health benefits of these spices despite their suitability for dietary diversification. This study therefore sought to create an awareness on these two spices by analyzing the factors affecting consumers' awareness of medicinal potentials of *Allium sativum* and *Allium cepa* among rural households in Imo State, Nigeria.

METHODOLOGY

This study was carried out in some selected LGAs of Imo state, Nigeria. Imo State has a total land area of 5,081 km2 and a population of 3.94 million (Federal Republic of Nigeria, 2009). The State lies within latitudes 4°45'N and 7°15'N, and longitude 6°50'E and 7°25'E. It covers an area of 532,000 ha, with an arable area of approximately 300,000 ha. (Imo State Government, 2000). The Imo people are predominantly subsistence farmers with Igbo being their major language.

This study made use of a structured questionnaire to elicit information on socio-economic and demographic characteristics from household heads using a multi-stage sampling procedure. Four Local Government Areas (LGAs) in rural part of Imo State were purposively selected in the first stage and from each of the selected LGA two villages were randomly sampled in the second stage to give a total of eight villages. Stage three involved the selection of 20 households from each of the eight selected villages giving a total of 160 households selected with the household heads serving as the respondents. A total of 160 questionnaires were administered but only 140 were found useful for the analysis due to inconsistency in the information provided by the household heads.

The data collected were analysed using simple descriptive statistics, cross tabular analysis and probit regression estimates. The consumers' socio-economic characteristics such as age, sex, income level and educational level were described using simple descriptive statistics while the estimates of association between the consumers' knowledge on health benefits of *Allium spp.* and the period within which they consumed these spices were estimated

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using cross tabulation. The probit analysis was used to estimate the factors determining consumer's awareness of the health potentials of *Allium spp.* (onions and garlic). The model is specified as:

$Y = \beta_0 + \beta_i X_i + e_i$

Where β_0 is the intercept, β_I is the slope (co-efficient) of the independent variables, Y is a dichotomous variable which can assume a value of 0 if no awareness and 1 if there is awareness on the health potentials of *allium spp.*, X_i is a set of explanatory variables as follows: X_1 is primary education dummy (D = 1 if the respondent has primary education, 0 = if otherwise); X_2 is the sex of the respondents (0 = female, 1 = male); X_3 is the age of the respondents in years; X_4 is the marital status of the respondents in years (0 = single, 1 = married) X_5 is occupation dummy (D = 1 if respondents is engaged primarily in farming, 0 = if otherwise); X_6 is work experience of the respondents in years; X_7 is the household income in naira (₦).

RESULTS AND DISCUSSION

Demographic and Socioeconomic characteristics of household heads

Results in Table I show that more than half (55.7%) of the respondents were male, while 44.3% were female. This therefore means that, a higher percentage of the males in the rural area were prone to the awareness of health potentials of *allium spp*. A higher percentage (72.9%) of the male household heads were involved in farming as a means of livelihood. About half (50.7%) of the respondents had primary school level of education. The percentage of respondents that were aware of the medicinal potentials of *allium spp.* was inversely proportional to the educational status. This is due to the number of years for which the respondent has been exposed to formal education. An individual with higher level of education would be more exposed to literature on health benefits of spices than one with a lower or no education at all.

The results from Table I also show that most (48.6%) of the respondents had small to medium household size in the range (1-6 members) with very few (5.7%) having a larger household size of between 13-18 members.

The age of an individual is also important in knowing the level of awareness on the health benefits of *allium spp.* in Table I, the age group with a highest percentage (47.1%) were those between 22-45 years. This shows that most of the household heads were active and still able to garner knowledge.

Furthermore the results from Table I revealed that a higher percentage (81.4%) of the respondents were married and are prone to displaying more maturity to health issues of their households than their single counterparts.

Consumers' knowledge of health benefits of *allium spp.* and the period of Consumption.

The results in Table II show the relationship between consumers' knowledge of health benefits of garlic (*allium sativum*) and the period of consumption among rural household heads in Imo State. The result for assessment on garlic consumption revealed that most of the household heads who were adults and advanced in age consumed garlic for a period of 21-45years respectively but had poor (27.1%) knowledge of its health benefits. In all the period stated for garlic consumption among the household heads as shown in Table II, the highest percentages were indicative of "poor" knowledge on health benefits of garlic respectively.

However, the reverse was the case with onions (see table III) as most of the respondents indicated a very good (27.1%) knowledge base on the health potentials of the spice. This further showed that most of the respondents who had been consuming

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onions for a period of 21-45 years with the base knowledge of its health potentials were matured and well advanced in age. In all the period stated for onion consumption among the household heads as shown in Table III, the highest percentages were indicative of "very good" knowledge on health benefits of onions respectively.

Factors determining awareness of health benefits of *allium spp.*

The probit model was used to examine whether the variables; primary education, sex, age, marital status, occupation (trading and farming), house hold size and household income have significant effect on the level of awareness on health benefits of *allium spp.* or not. The result from Table IV showed the probability chi-square of the entire model as 0.0005 which is significant at 1% level of significance, meaning that the overall model is significant. Age, work experience and household income of the respondents were significant at 1% and 5% levels respectively.

Age was significant at 1% level of significance and shows a negative relationship with the dependent variable (-0.0221). This means that a unit increase in age of the respondents, decreases the likelihood of their awareness on the health potentials of *allium spp*. This may be as a result of their educational background which is basically informal and further explains the correlation with the young and middle age group and health awareness on onion and garlic.

Work experience of respondents was significant at 5% level of significance and has a positive effect on the dependent variable (0.0254). This implies that the greater the number of years a household head spends farming, greatly determines his/her exposure to the health benefits of *allium spp*. this could be further buttressed with the findings on the consumer knowledge on health benefits of onions and the period of consumption from table II.

Furthermore from Table IV the household income was significant at 1% level of significance and has a positive relationship with consumer awareness on the health benefits of *allium spp.* (6.69e-06). This therefore implies that a unit increase in the household income, will likely increase the awareness on health benefits of *allium spp.* among rural households. This change in household status could encourage the household head to improve his educational background which inadvertently also gives room for more exposure to literature that enhances awareness on healthy lifestyle.

CONCLUSION AND RECOMMENDATION

More males than females in the study area were aware of the health benefits of *allium spp*. The major occupation of the household heads was farming showing a direct relationship with sex. There was an inverse relationship between educational status of household heads and their awareness on the health benefit of *allium spp*. The period of consumption of *allium spp*. showed poor knowledge on awareness of health benefits for garlic and very good knowledge on awareness of health benefits for onions.

Based on the results of this study, work experience and income of household head had a positive relationship with awareness on health benefits of *allium spp*., therefore length of engagement of the rural household head in their primary occupation such as farming should be encouraged by the government. This could be in the form of providing basic incentives and capital for farming to be lucrative and thereby curbing rural-urban migration. This inadvertently helps to also improve household income which is a key factor for awareness on health benefits of *allium spp*.

Basically, more awareness on the health potentials of *allium spp*. should be

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propagated by research institutes using the public private partnership forum to help enlighten stakeholders on the benefits of consuming natural plant products such as onions and garlic than artificial seasonings.

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Table 1. Socio-economic characteristics and preference to medicinal plants of the respondents

Variables	Frequency	Percentage
Age		
22 - 45	66	47.14
46 - 65	60	42.86
66 – 85	14	9.98
Total	**140**	**100**
Sex		
Male	78	55.71
Female	62	44.29
Total	**140**	**100**
Marital Status		
Married	114	81.43
Single	26	18.57
Total	**140**	**100**
Occupation		
Farming	102	72.86
Non-Farming	38	27.14
Total	**140**	**100**
Household Size		
1 - 6	68	48.57
7 - 12	64	45.72
13 – 18	8	5.71
Total	**140**	**100**
Education		
Primary	71	50.71
Secondary	44	31.43
Tertiary	7	5.0
Adult Education	9	6.43
Non-literate	9	6.43
Total	**140**	**100**

Source: Field survey 2015

Table 2. Period of consumption and knowledge on health benefits of garlic (*allium sativum*).

	Knowledge on health benefits of garlic				
Period (Years)	Very Poor	Poor	Fair	Good	Very Good
3 -10	3 (2.14)	10 (7.14)	2 (1.43)	-	1 (0.71)
11 – 20	9 (6.43)	18 (12.86)	5 (3.57)	4 (2.86)	2 (1.43)
21 – 45	14 (10.0)	38 (27.14)	14 (10.0)	2 (1.43)	-
46 – 75	1 (0.71)	14 (10.0)	3 (2.14)	-	-

Source: Field survey 2015

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Table 3. Period of consumption and knowledge on health benefits of onions (*allium cepa*).

	Knowledge on health benefits of onion				
Period (Years)	Very Poor	Poor	Fair	Good	Very Good
3 -10	3 (2.14)	10 (7.14)	2 (1.43)	-	1 (0.71)
11 – 20	9 (6.43)	18 (12.86)	5 (3.57)	4 (2.86)	2 (1.43)
21 – 45	14 (10.0)	38 (27.14)	14 (10.0)	2 (1.43)	-
46 – 75	1 (0.71)	14 (10.0)	3 (2.14)	-	-

Source: Field survey 2015

Table 4. Probit model results

Variable	Coefficient	Standard error	Ratio (Probability)
Age	-0.0221***	0.0091	2.44
Sex	0.0658	0.2282	0.29
Marital Status	0.0178	0.2924	0.06
Work experience	0.0254**	0.0123	2.06
Occupation of HHH	0.1925	0.2628	0.73
Educational qualification	-0.1506	0.1188	-1.27
Household income	6.69e-06***	2.23e-06	3.00
Constant	-0.5205	0.6981	-0.75

Source: Field survey, 2015

Diagnostic statistics: Prob >chi^2 = 0.0005; Pseudo R^2 = 0.1423; Log Likelihood = -77.74694;

****, ** show significant levels at 1% and 5% respectively*

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Abstract
The long-term micronutrient malnutrition problem of the rural populace cannot be solved by food aid or food trade alone but rather by the adequate utilization of indigenous plant foods such as spices. This study was aimed at assessing the consumers' awareness of the medicinal potentials of two Allium spp. (Onion and garlic) among rural households in Imo State, Nigeria. Data for the study were obtained from one hundred and forty (140) respondents made up of mostly farmers in four (4) Local Government Areas (LGAs) in the state namely; Nwangele, Orlu, Isi-ala mbano and Okigwe LGAs respectively using a well-structured questionnaire as interview schedule. Data were analysed using simple descriptive statistics, cross tabular analysis and probit regression estimates. Results showed that more than half of the respondents (55.7%) were males and 47.1% were in the age bracket of 22-45 years. The study also revealed that 48.6% of the respondents had an average household size of 1-6 people while about a half (50.7%) of the respondents had primary level of education. The general health perception about onions when cross-tabbed with the period of consumption by respondents revealed the highest score (27.1%) in the "very good" category among those who had been consuming onions for 21-45 years on average, whereas for garlic, the highest perception score (27.1%) was found in the "poor" category amongst those who had been consuming the spice for a period of 21-45 years. The probit regression result showed that age, work experience and household income were the socio-economic factors influencing the health awareness of Allium spp. in the study area. It is however recommended that more awareness on the medicinal potentials of garlic as a spice be heralded by agricultural extension officers via seminars, field visits and radio jingles in order to boost its consumption viz-a-viz it's marketability in the study area.
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INTRODUCTION

Spices have micronutrient and antioxidant potentials of which their consumption in whole or in use as condiments can be a means of dietary diversity in ameliorating micronutrient deficiencies (Oladejo and Oladele, 2013). *Allium Spp.* (onion and garlic) are spice plants of high value economically, nutritionally and medicinally that offer significant portions of micronutrients (potassium, iron, magnesium, calcium and sulphur) to the diet and therefore essential for the general well-being of humans. Onion (*Allium cepa L.*) is a natural part of the daily diet for most of the world's population (Mogren *et al.*, 2008; Sohail *et al.*, 2011). The World Health Organization (WHO) supports the use of onions for the treatment of poor appetite and to prevent atherosclerosis. It is widely cultivated second only to tomato and is a vegetable bulb known to most cultures and consumed worldwide (FAO, 2012). In addition, onion extracts are recognized by W.H.O for providing relief in the treatment of coughs and colds, asthma and bronchitis.

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$Y = \beta_0 + \beta_i X_i + e_i$

Where β_0 is the intercept, β_I is the slope (co-efficient) of the independent variables, Y is a dichotomous variable which can assume a value of 0 if no awareness and 1 if there is awareness on the health potentials of *allium spp.*, X_i is a set of explanatory variables as follows: X_1 is primary education dummy (D = 1 if the respondent has primary education, 0 = if otherwise); X_2 is the sex of the respondents (0 = female, 1 = male); X_3 is the age of the respondents in years; X_4 is the marital status of the respondents in years (0 = single, 1 = married) X_5 is occupation dummy (D = 1 if respondents is engaged primarily in farming, 0 = if otherwise); X_6 is work experience of the respondents in years; X_7 is the household income in naira (₦).

RESULTS AND DISCUSSION

Demographic and Socioeconomic characteristics of household heads

Results in Table I show that more than half (55.7%) of the respondents were male, while 44.3% were female. This therefore means that, a higher percentage of the males in the rural area were prone to the awareness of health potentials of *allium spp*. A higher percentage (72.9%) of the male household heads were involved in farming as a means of livelihood. About half (50.7%) of the respondents had primary school level of education. The percentage of respondents that were aware of the medicinal potentials of *allium spp.* was inversely proportional to the educational status. This is due to the number of years for which the respondent has been exposed to formal education. An individual with higher level of education would be more exposed to literature on health benefits of spices than one with a lower or no education at all.

The results from Table I also show that most (48.6%) of the respondents had small to medium household size in the range (1-6 members) with very few (5.7%) having a larger household size of between 13-18 members.

The age of an individual is also important in knowing the level of awareness on the health benefits of *allium spp.* in Table I, the age group with a highest percentage (47.1%) were those between 22-45 years. This shows that most of the household heads were active and still able to garner knowledge.

Furthermore the results from Table I revealed that a higher percentage (81.4%) of the respondents were married and are prone to displaying more maturity to health issues of their households than their single counterparts.

Consumers' knowledge of health benefits of *allium spp*. and the period of Consumption.

The results in Table II show the relationship between consumers' knowledge of health benefits of garlic (*allium sativum*) and the period of consumption among rural household heads in Imo State. The result for assessment on garlic consumption revealed that most of the household heads who were adults and advanced in age consumed garlic for a period of 21-45years respectively but had poor (27.1%) knowledge of its health benefits. In all the period stated for garlic consumption among the household heads as shown in Table II, the highest percentages were indicative of "poor" knowledge on health benefits of garlic respectively.

However, the reverse was the case with onions (see table III) as most of the respondents indicated a very good (27.1%) knowledge base on the health potentials of the spice. This further showed that most of the respondents who had been consuming

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Factors determining awareness of health benefits of *allium spp*.

The probit model was used to examine whether the variables; primary education, sex, age, marital status, occupation (trading and farming), house hold size and household income have significant effect on the level of awareness on health benefits of *allium spp.* or not. The result from Table IV showed the probability chi-square of the entire model as 0.0005 which is significant at 1% level of significance, meaning that the overall model is significant. Age, work experience and household income of the respondents were significant at 1% and 5% levels respectively.

Age was significant at 1% level of significance and shows a negative relationship with the dependent variable (-0.0221). This means that a unit increase in age of the respondents, decreases the likelihood of their awareness on the health potentials of *allium spp*. This may be as a result of their educational background which is basically informal and further explains the correlation with the young and middle age group and health awareness on onion and garlic.

Work experience of respondents was significant at 5% level of significance and has a positive effect on the dependent variable (0.0254). This implies that the greater the number of years a household head spends farming, greatly determines his/her exposure to the health benefits of *allium spp*. this could be further buttressed with the findings on the consumer knowledge on health benefits of onions and the period of consumption from table II.

Furthermore from Table IV the household income was significant at 1% level of significance and has a positive relationship with consumer awareness on the health benefits of *allium spp.* (6.69e-06). This therefore implies that a unit increase in the household income, will likely increase the awareness on health benefits of *allium spp*. among rural households. This change in household status could encourage the household head to improve his educational background which inadvertently also gives room for more exposure to literature that enhances awareness on healthy lifestyle.

Conclusion and Recommendation

More males than females in the study area were aware of the health benefits of *allium spp*. The major occupation of the household heads was farming showing a direct relationship with sex. There was an inverse relationship between educational status of household heads and their awareness on the health benefit of *allium spp*. The period of consumption of *allium spp*. showed poor knowledge on awareness of health benefits for garlic and very good knowledge on awareness of health benefits for onions.

Based on the results of this study, work experience and income of household head had a positive relationship with awareness on health benefits of *allium spp*., therefore length of engagement of the rural household head in their primary occupation such as farming should be encouraged by the government. This could be in the form of providing basic incentives and capital for farming to be lucrative and thereby curbing rural-urban migration. This inadvertently helps to also improve household income which is a key factor for awareness on health benefits of *allium spp*.

Basically, more awareness on the health potentials of *allium spp*. should be propagated by research institutes using the public private partnership forum to help enlighten stakeholders on the benefits of consuming natural plant products such as onions and garlic than artificial seasonings.

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Table 1. Socio-economic characteristics and preference to medicinal plants of the respondents

Variables	Frequency	Percentage
Age		
22 - 45	66	47.14
46 - 65	60	42.86
66 – 85	14	9.98
Total	**140**	**100**
Sex		
Male	78	55.71
Female	62	44.29
Total	**140**	**100**
Marital Status		
Married	114	81.43
Single	26	18.57
Total	**140**	**100**
Occupation		
Farming	102	72.86
Non-Farming	38	27.14
Total	**140**	**100**
Household Size		
1 - 6	68	48.57
7 - 12	64	45.72
13 – 18	8	5.71
Total	**140**	**100**
Education		
Primary	71	50.71
Secondary	44	31.43
Tertiary	7	5.0
Adult Education	9	6.43
Non-literate	9	6.43
Total	**140**	**100**

Source: Field survey 2015

Table 2. Period of consumption and knowledge on health benefits of garlic (*allium sativum*).

	Knowledge on health benefits of garlic				
Period (Years)	Very Poor	Poor	Fair	Good	Very Good
3 -10	3 (2.14)	10 (7.14)	2 (1.43)	-	1 (0.71)
11 – 20	9 (6.43)	18 (12.86)	5 (3.57)	4 (2.86)	2 (1.43)
21 – 45	14 (10.0)	38 (27.14)	14 (10.0)	2 (1.43)	-
46 – 75	1 (0.71)	14 (10.0)	3 (2.14)	-	-

Source: Field survey 2015

Table 3. Period of consumption and knowledge on health benefits of onions (*allium cepa*).

	Knowledge on health benefits of onion				
Period (Years)	Very Poor	Poor	Fair	Good	Very Good
3 -10	3 (2.14)	10 (7.14)	2 (1.43)	-	1 (0.71)
11 – 20	9 (6.43)	18 (12.86)	5 (3.57)	4 (2.86)	2 (1.43)
21 – 45	14 (10.0)	38 (27.14)	14 (10.0)	2 (1.43)	-
46 – 75	1 (0.71)	14 (10.0)	3 (2.14)	-	-

Source: Field survey 2015

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Table 4. Probit model result

Variable	Coefficient	Standard error	Ratio (Probability)
Age	-0.0221***	0.0091	2.44
Sex	0.0658	0.2282	0.29
Marital Status	0.0178	0.2924	0.06
Work experience	0.0254**	0.0123	2.06
Occupation of HHH	0.1925	0.2628	0.73
Educational qualification	-0.1506	0.1188	-1.27
Household income	6.69e-06***	2.23e-06	3.00
Constant	-0.5205	0.6981	-0.75

Source: Field survey, 2015
Diagnostic statistics: Prob >chi^2 = 0.0005; Pseudo R^2 = 0.1423; Log Likelihood = -77.74694;
****, ** show significant levels at 1% and 5% respectively*

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Socio-Economic Analysis of Dry Season Vegetable Farming among Women in Makurdi Local Government Area of Benue State, Nigeria.

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Abstract
The study assessed the profitability of dry season vegetable farming among women in Makurdi Local Government Area of Benue State. Responses were obtained from 60 dry season vegetable farmers with the aid of a well-structured questionnaire. Data were analysed using simple descriptive statistics, OLS regression and gross margin analysis. Majority (70.0 %) of the women engaged in dry season vegetable farming were married (93.3%), within the age bracket of 31-40, literate (100.0%), with household size of 6-10 persons (43.3%) and 6-10 years farming experience (48.3%) but had no access to extension services (61.7%). R^2 value was 0.727, implying that the regression model accounted for about 73.0% of none zero variations in the model. Furthermore, age, farming experience, source of credit, access to extension contact and farm size had correlation with farmers' income. Gross margin and return on investment in dry season vegetable farming were ₦36, 858.33 and 1.6 respectively. Major constraints observed by dry season vegetable farmers were high cost of irrigation equipment, pest and disease infestation, inadequate inputs, inadequate credit facilities and high cost of transportation. Dry season vegetable farming was a profitable business in the study area. Women engaged in dry season vegetable farming should be encouraged to come together as a cooperative society in order to better harness available opportunities. There is dire need for subsidisation of farm inputs prices, construction of bore-holes and development of river basin irrigation schemes amongst others in the study area.
*Keywords**:** Vegetable farming, dry season farming, women farmers, return on investment, and income.*

INTRODUCTION

In Nigeria, about 90% of the country's food is produced by small-scale farmers cultivating tiny plots of land who depend on rainfall rather than irrigation systems. One of the major items produced is vegetable. The importance of vegetables as major and efficient sources of micronutrients in African diet cannot be over stressed (Annon, 2015). Vegetables are known to enrich some diets with nutrients including lipids, carbohydrates and vitamins (Komolafe *et al.,* 2010). Vegetable crops are important for almost every household. According to Dittoh (2012), vegetables add flavor to the food and also provide considerable protein, vitamins and minerals. Onuk, *et al.,* (2017), reported that vegetable crops not only improve the nutritional quality of diets, but the production under irrigation and marketing provides many people with employment in the dry season. It is estimated that about 70% of the vegetables produced in Nigeria is marketed and consumed fresh (Danso *et al.,* 2003).

In Nigeria, there are two distinct seasons, the rainy season and the dry season. The rainy season is the normal cropping season and this starts from April and ends in October, while the dry season starts from November and ends in March. During the rainy season, the production of vegetable is high resulting in the saturation of the market, but during the dry season there is usually the scarcity of this important crop thereby leading to high price (Ibekwe and Adesope, 2010). This has implication for accurate assessment of the potentials of dry season vegetable production as a source of income for the farmers. This study therefore, was designed to analyze profit maximization among dry season vegetable farmers in Makurdi LGA of Benue State. Specifically, the study described the socioeconomic characteristics of women engaged in dry season vegetable farming; examined the factors affecting dry season vegetable farming, determined the profitability of dry season vegetable farming; and identified problems militating against women vegetable farmers.

MATERIALS AND METHODS

This study was conducted in Makurdi LGA, Benue State, Nigeria. Makurdi has an estimated population of 600,797 people (National Population Commission (NPC), 2006) with a land area of 804 square kilometers. The city is located in central Nigeria and lies on the south bank of the Benue River with latitude 7°43'North and longitude 8°35' East. It is bounded on the West and North by Lafia, Keana and Doma Local Government of Nasarawa State, on the east by Guma Local Government (LG) and on the South by both Gwer and Gwer-West LGs. Makurdi is made up of eleven (11) districts and the major ethnic groups are the Tiv, Idoma and Igede who are mainly farmers. Crops such as yam, soya-beans, corn, groundnut etc. are produced in the local government in a large quantity. Also commerce constitutes the main stay or revenue generation to the State (NPC, 2006).

Makurdi is characterized with two seasons, the rainy and dry season. The rainy season start from late April–October with annual rainfall of about 1500mm with highest rainfall in the months of August to September, while the dry season commences from November to Late March.

Dry season vegetable women farmers in Makurdi LGA were sampled for this study. They were selected through a multi-stage sampling procedure. The first stage was the random selection of three (3) districts in Makurdi LGA. The second stage involved the purposive selection of four (4) villages from each of the selected districts. Finally, five (5) vegetable women farmers were randomly selected from each of the four (4) villages and this gives rise to sixty (60) respondents for the study. Data was collected with the aid of structured questionnaire designed to elicit information from the respondents.

Descriptive statistics such as frequency, tables and percentages were used to profile information about the socio-economic characteristics of the population under study (objective i and iv), budgetary analysis (cost and returns) was used to satisfy objective iii, while the Ordinary Least Square Regression (OLS) was used to determine factors influencing dry season vegetable farming and profitability in the study area (objective ii and iii).

The Gross Margin budgeting technique is given as: GM/ha-TVC/ha ....(1)

Where GM = Gross Margin (N/ha)

TR (Total Revenue) = Quantity of output (N/ha)

TVC (Total Variable Cost) = Quantity of input (N/ha)

TC (Total Cost) = TFC+TVC in Naira

$$RNI = \frac{GM}{TVC} \quad \ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

Where: RNI = Return per Naira Invested

The OLS model is given as:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 \ldots. \beta_7 x_7 + U$$

Where Y = is the income of women veg etables farmers

β_0 = Constant

$\beta_1 - \beta_7$ = Parameter coefficients of the exp lanatory variables

$x_1 - x_7$ = Explanatory variables

U = Error term

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

Results in Table 1 showed that majority (93.3%) of the women engaged in dry season vegetable production were married, educated (100.0%), within age bracket of 31-40 years (70.0%), with household size of 6-10 persons (43.3%), and 6-10 years farming experience (48.3%). Implication

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of these results is that the farmers were in their productive age. This supports the findings of Bawa *et al.,* (2010) who reported that women involved in dry season vegetable farming in Borno State, North-East Nigeria, were within the economically productive age range of 18-40 years. Ogumbameru (2001) asserted that young and middle-aged people are the most active in agricultural production activities for increased productivity. Also, the larger proportion of married people implied more mouth to be fed because married households have the tendencies to have more children to carter for, while longer farming experience could imply that the farmers were expertise in their occupation. The fact that most of the farmers were educated implied that they are likely to understand and adopt new technologies. Education has been discovered to be highly related to effectiveness of work and economic function (Meskel, 2006). Large household size could provide ample labour supply for farming but could also result in more mouths to feed which could put more pressure on household income and resources. Furthermore, Table 1 showed that majority (61.7%) of the women engaged in dry season vegetable farming had no access to extension contact, while only 15.0% had contact just once. This is an indication of poor extension service delivery, and may be attributed to the fact that women in the study area may be disregarded in any agricultural extension services affecting them due to the socio-cultural factors in Nigeria. The relationship between agricultural extension agent and the farmer is an important factor towards agricultural production expansion (Amaza, 2005). Majority (73.3%) of the women engaged in dry season vegetable farming employed both hired and family labour to carry out their vegetable farming. This result showed that women engaged in dry season vegetable farming in Makurdi LGA depend mostly on both hired and family labour in carrying out farm operations. Mean farm size was 0.24 hectare indicating that most of the women engaged in dry season vegetable farming were small holders and this may be due to women's limited access to productive resources in the study area.

Factors affecting dry season vegetable farming

The results of the regression analysis as presented in Table 2 revealed that the value of the regression co-efficients (R^2) was found to be 0.727. This implies that the regression model accounted for about 73.0% of none zero variations in the study model. This showed that independent variables explained about 73.0% of variations in the income of women vegetable farmers. Thus, the regression has a good fit to explain the relationship of income and socio-economic factors of the women involved in dry season vegetable farming. Results in Table 2 showed that age, farm size and access to extension contact were significant at one percent level, while farming experience and source of credit were significant at five percent. The regression analysis also revealed that age was negatively correlated with farmers' income. This means that an increase in age of farmers will lead to reduced income. Furthermore, farm size, source of credit and farming experience were also found to be positively correlated with income. This means that an increase in the farm size, source of credit and farming experience would lead to an increase in income of the farmers. Farm size was found to be positively correlated. This implies that an increase in the magnitude of this important variable will definitely lead to an increase in income from vegetable production.

Profitability of dry season vegetable farming

Results of the gross margin analysis as presented in Table 3 revealed that, the average variable cost per hectare of

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vegetable production was ₦23, 533.34 which represents 62.8% of the total cost of production, while total cost of production of vegetable per hectare was ₦37, 466.67. Total Revenue (TR), Gross Margin (GM), Total Variable Cost (TVC), and Return on Investment (ROI) were ₦60, 391.67, ₦36, 858.33, ₦23, 533.34 and ₦1.6 respectively. The value of the GM obtained indicated that vegetable production is an essential source of income for rural women in the study area. Also it was also observed that for every naira invested, a profit of ₦0.57 was realized. Information from the profitability analysis showed that dry season vegetable farming is a viable business in the study area with a profit margin of ₦22, 925.25 per hectare. These results implied that dry season vegetable production is a profitable business in the study area.

Constraints of dry season vegetable Farming

Results displayed in Table 4 shows the constraints faced by women engaged in dry season vegetable farming in the study area. The constraints high cost of irrigation equipment (91.7%), pest and disease infestation (80.0%), inadequate inputs (28.3%), inadequate credit facilities (5.0%) and high cost of transportation (5.0%). More than 90 percent of the farmers had problem of high cost irrigation equipments. About 80.0% of the farmers were confronted with the problem of pest and disease attack. Inadequate farm inputs constituted 28.3%. Also 5.0% were faced with inadequate credit facilities and high cost of transport.

CONCLUSION AND RECOMMENDATIONS

The study assessed the profitability and constraints of dry season vegetable farming among women in Makurdi Local Government Area (LGA) of Benue State. Findings from the study revealed that majority (70.0 %) of the respondents were within the age bracket of 31-40, educated (71.1%) and with 6-10 years farming experience (48.3%). Age, farm size, farming experience, source of credit and access to extension contact influenced income of respondents

Budgetary analysis revealed that dry season vegetable farming is a profitable business in the study area. Major constraints of dry season vegetable farming includes high cost of irrigation equipment, inadequate credit facilities, high cost of transportation, inadequate input and incidence of pest and disease. This has implication for economy of scale. It is also important to note that the study area is land deficient as the average farm size was found to be 0.093 ha. This has implications for intensive agriculture and off farm incomes.

Based on the findings from this study and conclusion drawn, the following recommendations are made: -

i. Women involved in vegetable farming should be encouraged come together as cooperatives societies in order to access credit facilities from government, NGOs and financial institutions.
ii. The price of farm inputs such as irrigation facilities should be subsidized so as nto make them accessible and affordable to vegetable farmers.
iii. There is need for construction of boreholes and develop river basin irrigation schemes to ensure steady supply of water for dry season vegetable farming.
iv. Extension services should be provided to update women farmers on recent global trend in vegetable production.

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Table 1: Socio-economic charactersistics of respondents

Characteristics	Frequency	Percentage	Mean value
Gender			
Female	60	100.0	
Age			
20-30	8	13.3	
31-40	42	70.0	35.9
41-50	10	16.7	
Total	60	100.0	
Marital status			
Single	4	6.7	
Married	56	93.3	
Total	60	100.0	
Farming experience			
6-10	29	48.3	
11-15	19	31.7	
16-20	6	10.0	9.6
>20	6	10.0	
Total	60	100.0	
Household size			
1-5	24	40.0	
6-10	26	43.3	
11-15	10	16.7	6.1
Total	60	100.0	
Type of farming			
dry season farming	41	68.3	
Both	19	31.7	
Total	60	100.0	
Educational status			
Primary	17	28.3	
Secondary	40	66.7	
Tertiary	3	5.0	
Total	60	100.0	
Frequency of extension contact			
None	37	61.7	
Once	9	15.0	
Twice	14	23.3	
Total	60	100.0	
Farm size			
less than one	60	100.0	0.25
Type of labour used			
Family labour	2	3.3	
Hired labour	14	23.3	
Both	44	73.3	
Total	60	100.0	

Source: Field Survey, 2017

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Table 2: Factors affecting dry Season vegetable farming

Variables	Coefficients	Standard error	T-value
(Constant)	5.870	1.901	3.088***
Source of credit	0.180	.504	.358**
Extension contact	0.388	.383	1.013***
Farm size	1.107	1.348	.821***
Household size	0.016	.011	1.455
Farming experience	0.155	.071	2.201**
Educational status	0.051	.081	.629
Age	0.244	.058	4.207***

Source: Field Survey, 2017
R^2 = 0.727, F-Value = 19.79
***, ** level of significance at 1% and 5%,

Table 3: Profitability of Vegetable Production

Cost and Return Items	Mean Value (₦/kg)	Percentages of Variable Cost
A) Variable Cost (Naira)		
Fertilizer	8,708.33	37.00
B) Labour		
Planting	2,900.00	12.32
Weeding	4,191.67	17.81
Agrochemicals	4,566.67	19.41
Transport	3,166.67	13.46
Total Variable Cost (TVC)	**23,533.34**	
C) Fixed Cost (FC) (Naira)		
Land	3,453.20	
Irrigation equipment	10,480.13	
Total Fixed Cost (TFC) (Naira)	**13,933.33**	
D) Total Cost (TC) (Naira) (TFC+TVC)	37,466.67	
E) Total Revenue (TR) (Naira)	60,391.67	
Net Return (NR) = TR-TC	22,925.00	
Gross Margin (GM) = TR-TVC	36,858.33	
Return Per Naira Invested	1.6	

Source: Field Survey, 2017.

Table 4: Constraints of dry season vegetable production

Constraints	Frequency	Percentage	Rank
High cost of irrigation equipments	55	91.7	1st
Pest and disease problem	48	80.0	2nd
Inadequate inputs	17	28.3	3rd
Inadequate credit	3	5.0	4th
Transportation	3	5.0	5th

Source: Field Survey, 2017

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Factors of fluted Pumpkin out- Put Determinants in Bende Local Government Area of Abia State, Nigeria

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Abstract
The study examined the determining factorsof fluted pumpkin output in Bende Local Government Area of Abia State, Nigeria. A total of 60 respondents selected through random and purposive sampling techniques were interviewed using a well structured questionnaire. Data collected were analyzed using descriptive statistics and multiple regression analysis. The results revealed thatmajority (89%) of the farmers was females, mean age of the farmers was 39 years and 88.33% of the farmers were literates. Majority(83.33%) of the farmers was married and the mean household size of the farmers was 7 persons per household. Majority of the farmers (60%) reported having access to credit facilities. Mean years of farming experience of the farmers was 13 years while average farm size of the farmers was 0.62 ha. A coefficient of multiple determinations,(R^2) was 67.53 % which indicated high relevance of the determinants in explaining the observed variation in fluted pumpkin output. From the regression result, 6 regression coefficients were statistically significant (age, access to credit facility, labor source, household size, educational level and farming experience) while one [marital status]was not statistically significant . Based on the findings of the result, it is recommended that enhancing fluted pumpkin farmers access to cultivable land and credit facilities should be made available to them in form of soft loans to enable them procure necessary inputs for production through favorable policies which will increase output.
Keywords: *determinants factors, fluted pumpkin output, regression analysis*

INTRODUCTION

Fluted pumpkin (*Telfairiaoccidentalis*) is a major component of the dietsof West African populace particularly in Nigeria. It is though a perennial crop but usually cultivated all year round through irrigation. It belongs to the family cucurbitaceace and originated from West Africa, cultivated primarily for its nutritious leaves and seeds (Greensill, 1968;Schipper, 2000). Fluted pumpkin is an important food crop especially in the region of West Africa.Apart from being widely consumed in various parts of the country by all religious and social classes, fluted pumpkin plays a prominent role in the medicine and economic life of the people. Its cultivation creates employment and income opportunities for vast population of the rural farmers. Fluted pumpkin is among the crops of which their production is dominated by small scale poor resource rural farmers with farm holdings of less than 2hectares, a typical characteristics of subsistence agriculture of which is responsible for 95% of their total output.In addition, Olukosiand Isitor (1990) identified several possible limiting factors to large scale agriculture in time past which ranges from limited access to credit facilities, low farm gate price, high cost of labour input, and inadequate supply of modern technology farm input and inefficient use of resources to inefficient marketing system. According to Attavar (2000) fluted pumpkin as a vegetable has a recommendation of 285g/person/day on the human average, being the source of daily vitamins, minerals, protein and dietary fibres intake for the large Nigerianpopulace. As a food crop, fluted pumpkin contribute 250- 325g of a balanced diet per daily for about 353 million people in West Africa while servicing as an important source of income to the people(Attavar,2000). Fluted pumpkin is rich in protein 29%, fat 18%, minerals (contain high levels of potassium and iron) and vitamins 20% while the fluted pumpkin seedis considered as an

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"oil seed", has 53% fat and 27% crude protein (Ndoret *al*. 2013;Odiaka, 2001).As a food security crop in West Africa,fluted pumpkin can be eaten in diverse ways - in soup, yam porridge, stew and sauce preparation.Fluted pumpkin output has increased overtime. This increase is however attributed to increased demand based on nutritional value though still cultivated by small scale farmers(Nwachukwu*et al*, 2009).Due to the much awareness and immense rural and regional economics contribution of fluted pumpkin to many household(Adebisi-Adelani*et al*., 2011) and its significance among the food crops in Nigeria. Thus there is need for further investigation intodeterminants factors of fluted pumpkin output in Bende Local Government Area of Abiastate.

METHODOLOGY

Description of the Study Area and Sampling Technique

The study was conducted in Bende Local Government Area of Abia State. Bende Local Government Area is bounded by Arochukwu, Ohafia,Umuahia North, Ikwuano and Isuikwuato Local Government Areas with coordinates of 5º34" N and 7º38"E of the Greenwich meridian, which covers a total land area of 306.3 square km and a population of 128,227 at the 2006 census (National Population Commission, NPC 2006). Two state constituencies of Bende Local Government Area namely – Bende North and Bende South state constituencies were chosen. This local government was purposely chosen for the study because the people are predominantly farmers. From the chosen state constituencies,two villages where pumpkin is grown extensively were randomly selected in the ratio of one per State constituency (1:1). Bende village was chosen from Bende South and Item villagefrom Bende North respectively. Thirty (30) pumpkin farmers were selected in each of the villages with the help of key informants of pumpkin growers in the area. This gave a total of 60 respondents for the study.

Method of data analysis

Data collected were analyzed with descriptive statistics and regression analysis. The implicit model of the regression is $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, e_i)$.

Where: Y = Value of Fluted Pumpkin Leaf Production (₦);

X_1= Farmer's age (years)

X_2 = Farmer's marital status (Dummy variable; Married=1, Single = 2, Divorced = 3, Widow = 4);

X_3 = Farmer's Household size (number of person);

X_4 = Farmer's Level of education (Non Formal education = 1, Primary education = 2, Secondary education = 3, Tertiary education = 4, Adult education = 5);

X_5 = Fluted Pumpkin farming experience (years);

X_6 = Access to credit facility (Dummy variable; yes = 1, No = 0);

X_7 = Farmer's source of labor (Dummy variable; hired labor = 1, family labor =2,); and

e_i= Error term.

RESULTS AND DISCUSSION

The distribution of the respondents according to their socio-economic characteristics is shown in Table 1. From the table, most of the respondents (36.67 percent) fall within the age bracket of 31 - 40 years with mean age of 39years.Again 83.33 percent weremostlywomen below the age of 50 and otherswere young and middle aged.This finding is consistent with Emenyonu*et al*. (2010) who found that majority of women are involved in fluted pumpkinoutput and intermsof age, this implies that majority of the fluted pumpkin farmers in the study area are in their economic active age.On level of educational attainment, 88.33 percent of fluted pumpkin farmers attained one form of formal education or the other ranging

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from primary to tertiary education.Agbamu, (1993), reported that there was a positive correlation between level of education and adoption of innovations and formal education had a positive influence on adoption of innovations. Therefore, a higher level of adoption of new technology for fluted pumpkin output may be expected in the study area. Table 1 also showed that most of the respondents (89 percent) were females while 83.33 percent were married. Household size of 6-10 wasdominant, representing 68.33percent of the entire households.This is an indication that a large family is still a common practice among farmers as they often depend on family labour. Family labour is important because household size is the principal determinant of labour availability in small-scale farming given the relatively soaring cost of hired labor. This distribution of household size of 6-10 in the area could either enhance or retard output efficiency depending on whether the households provide the farm labour or not and how such labour is utilized. From Table 1 also, it can be observed that with mean of 13 years farming experience, the farmers are knowledgeable and experienced in fluted pumpkin crop farming, increased farm output and also enhanced their ability to understand and evaluate new output technologies.According the respondents farm size, most of the respondents (61.67 percent) cultivated on 0.8 hectare of land, while 15.00 percent cultivated on 1.2hectares. The average farm size of the farmers was 0.62 ha implying that the farmers are mainly small-scale farmers. This is disadvantageous because to a large extent, farmsize determines output level.The small land holding may not be unconnected with the prevalent land tenure system in the study area which is mainly by inheritance.The result in Table 1 shows that 63.3 percent of the farmers used family labour, 36.7 percent employed hired labour. This shows that most of the farmers used their family members for farmingactivities. This agreeswith thefindings of Rahman and Mali (2003) observed that majority of the small scale farmers are poor and usually utilize family labour.

Factors offluted pumpkin output determinants

In order to determine factors influencingfluted pumpkin leaf outputs in the study area, a multiple regression analysis was done in four functional forms (linear, semi log, double log, and exponential forms). The linear function was chosen as the lead equation. The reason for the choice of the linear form as the lead equation is because it has the highestR^2value (0.6753). The result presented in Table 2 shows how factors (socio-economic)of respondent influenced fluted pumpkin production output.

The coefficient of multiple determinations (R^2) was found to be 67.53 percent. This implies that the explanatory variables explained up to 67.53 percent variations in fluted pumpkin leaf output in the study area and that the regression has a high explanatory power. From the regression result, six regression coefficients were statistically significant and positive (age, labor source, house hold size, educational level, farming experience and farm size) while marital status was not statistically significant. The regression coefficient of age and level of education were very positive andsignificant at 1% level of probability each. This implies that age has a direct relationship on the output of fluted pumpkin leaf while level of education also has a direct relationship with the fluted pumpkinoutput of farmers. The level of educationtends to increase with the output. The coefficient of household size, access to credit and years of farming experiencewere significant at the 5% level and also positive each. Farmers with larger households recorded higher outputthan

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farmers with smaller households while years of farming experienceresult indicates thatthe more experienced farmers recorded higher output than the less experienced farmers. Access to credit facility at 5% significant level implies that increase in the availability of agricultural credit facilities may lead to increase in fluted pumpkin output. Labour source as a positive coefficient variable that is significant at the 10 % level of probability shows that farmers made use of family labour than hired labour because majority of the farmers practice subsistence agriculture. The f-ratio which determines the overall significance of the regression is significant at the 5% level implying that the explanatory variables jointly explained the variations observed in the dependent variable.

CONCLUSION AND RECOMMENDATION

The findings of this study revealed that the majority of the fluted pumpkin farmers were married, young, educated, experienced and small scale female farmers.Provisions should be made that will tend to relocate inputs especially fertilizer and credit to fluted pumpkin leaf output and particularly to the female farmers are necessary. Such provisions should be targeted more at experienced farmers with large household sizes, and small farm size, to increase their output scale. To ensure capital availability, farmers should organize thrift among themselves in terms of esusu, rotational contribution etc. Soft loan should be given to fluted pumpkin farmers through functional farmers cooperative societies. These farmers' cooperative societies will save as mechanisms for credit disbursement. In addition to farmers' cooperative societies, formal credit institutions like Nigerian Bank of Agriculture (BoA) should encourage farmers through financial empowerment and easy loan access.

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Table 1: Socio – Economic Characteristics fluted pumpkin farmers [n=60]

Age	Frequency	Percentage
21-30	11	18.33
31-40	22	36.67
41-50	17	28.33
51-60	9	15.00
61 and above	1	1.67
Mean	39.42	
Standard deviation	12.04	
Sex		
Male	7	11
Female	53	89
Marital Status		
Single	4	6.67
Married	50	83.33
Widowed	6	10.00
Divorced	-	-
Household size		
1-5	17	28.33
6-10	43	68.33
11-15	2	3.34
Mean	4.75	
Educational Status		
No Formal Education	2	3.34
Primary Education	5	8.33
Secondary Education	21	35.00
Tertiary Education	27	45.00
Adult Education	5	8.33
Years of Farming Experience		
1 –10	24	40.00
11- 20	20	33.33
21- 30	13	21.67
31 and Above	3	5.00
Mean	13.67	
Farm Size		
0.1 – 0.4	14	23.33
0.5 – 0.8	37	61.67
0.9 – 1.2	9	15.00
Mean	0.62	
Access to Credit		
Yes	24	40
No	36	60
Mean	1.60	
Farmers source of labour		
Hired	22	36.7
Family	37	63.3
Mean	1.63	

Source: Field survey 2016

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Table 2.Regression results for Socio – economic determinants of fluted pumpkin output

Variables	Parameters	Coefficients	Std. error	T-value
Constant	B_o	8554.619	18842.178	0.454
Age	X_1	5445.238	1864.976	2.920*
Marital Status	X_2	6666.768	4438.462	1.502
Household Size	X_3	6725.589	2706.881	2.485**
Education	X_4	5139.064	2034.467	2.526*
Years of farming experience	X_5	4174.237	1669.027	2.501**
Access to credit	X_6	9132.659	3666.262	2.491**
Labor source	X_7	6479.337	3246.161	1.996***
F- Static	2.48**			
R	0.67			
R^2 adjusted	0.55			

Source*: Computed from field survey Data 2016*
* = statistically significant at 1%
**=statistically significant at 5%
***=statistically significant at 10%

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A Survey of Horticultural Crop Production in Neighborhood of NIHORT Mbato Out-Station, Okigwe Local Government Area, Imo State, Nigeria

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Abstract
The survey of horticultural crops production in neighborhood of NihortMbato out-station,okigwe local government area, Imo state was conducted in 2018.Five communities (Aku, Agbobu, Umulolo, Umuowa-Ibu and Okigwe urban) that surround the institute were surveyed. Both purposive and multistage random sampling techniques were adopted in selection of 64 farmers which made up the sample size. Primary data were collected using structured questionnaire from the sampled farmers. Data were analyzed with the use of statistical tools such as percentage and mean. The result of the study shows that majority (51.6%) of the farmers were females and 48.4% were males, majority (78.1%) were married while 100% of the farmers had one form of educational level or the other, however, secondary education was ranked highest with 45.3%. Also, from the survey 100% of the farmers are aware of orange production; followed byokro (90.6%), pawpaw (89.1%), pineapple (89.1%), banana (85.9%),mango (84.4%), maize (84.4%), andtelfairia (ugu) (84.4%).As a result 100% of the farmers are into production oforange, okro (84.4%), maize (84.4%),pineapple (84.4%), plantain(81.3%), pawpaw (78.1%) and telfairia (ugu) (71.9%).However, farmers are faced with challenges such as inadequate finance (M=3.45), inadequate access to loan (M=3.42) and lack of storage and processing facilities (M=3.34), consequently, it was recommended that farmers should form a good cooperative society which might help them to access loan from financial institutions to enhance their level of production, and subsequently attract the attention of government and non-governmental institutions who may provide both storage and processing facilities in the area.
Keywords: horticultural crops, awareness, production,farmers,challenges, percentages, mean.

INTRODUCTION

Horticulture is a section of agricultural sciences that employs scientific understanding to produce vegetables, fruits and flowers and enrich human diet. Horticulture is the science, technology, and business involved in intensive cultivation of plants for human use, including fruits, vegetables and ornamental plants (Alonso et al., 2013).Horticultural products play a major role in modern society and ecomony. They form the basis of a wide array of processed and partially processed products. Based on crop grouping and use the main division or branches of horticulture are Olericulture, a branch of horticulture which include the production of vegetable, processing and marketing. Floriculture is the cultivation and management of flowers, flowering plants and foliage plants. It also includes their uses in ornamental construction and floral arrangement (ISHS, 2011). Pomology, has to deal with the production of fruits and nuts that are basically perennials.

It is utilized by both, individuals and industries to enhance the nutritional and economic standards. Fruits and vegetables are some of the common horticultural crops and are a potential source of valuable nutrition (Flyman and Afolayan 2006). These series of vegetables may support to fulfill basicrequirements of human health and well-being.ICAR (2005) considered vegetables as potential crops for improving nutrition, food security and also to generate employment in the country. Fruits and vegetables play a significant role for improving income and nutrition since they are rich in vitamins, carbohydrates, anti-oxidants and other nutrients. Some nutritional deficiencies like vitamin A and C, and iron can be corrected by the use of selected vegetables and fruits. They are used either fresh or

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processed into paste, puree, ketchup, marmalade, jam, juice and butter (Olayemiet al., 2010).

Horticultural crops are the primary source of poverty reduction in most agriculture-based economies; this is so because the production of horticultural crops is a major source of cash income for the households (Mohammed and Afework 2016). The expansion of smallholder farming can lead to a faster rate of poverty alleviation, by raising the incomes of rural cultivators and reducing food expenditure, and thus reduces income inequality (Alemayehu Hailu Welderufael, 2016). In addition to poverty eradication, Sajo (2011) also asserted that numerous and varied income generation activities are in horticultural industry. These include ownership of small gardening activity, large scale vegetable production, marketer of horticultural produce. These opportunities are unique and endless. Horticultural activities offer considerable potential which may contribute significantly to poverty reduction and economic development if adequately exploited.Thus, horticultural production according to Weinberger & Lumpkin (2005) has been indicated as a sector that can provide real opportunities for enhancing farmincomes and reducing poverty in developing countries.However, most local farmers involved in horticulture practice peasant farming for consumption and for retailsale in the informal market, local communities and street corners in the cities (Madisa et al., 2012). Also,Alazar,(2007), opined that most of the horticultural crops produced by smallholder farmers are consumed locally. After harvest, they are transported to rural market centers for local consumers or are bought at the farm by neighbors. Others are transported to bigger market centers where many producers utilize the open-air markets once or twice a week. However, N. Rai and D.S. Yadaav (2005) said that vegetables are sold at higher rate than cereals and grains. If they are sold at a cheaper rate in the peak production season, then it is due to their high yield; they have high monetary value. During rainy season, some vegetables give very good income in comparing to grain and fodder crops. Market gardeners create substantial income from intensive cultivation of limited lands.

The constraining factors for horticultural crop are low production and productivity, lack of adequate pest control, poor soil management practices, finance, lack of attention to product quality and prevention of physical damage, as well as lack of storage and packaging facilities (Milaku, 2005). Also according to Madisa et al., 2012,horticultural crop farmers are mainlyconstrained by different factors which include; pests, water and shortage of basic farm inputs like seed andfertilizers.

Nigeria has a strong favorable soil condition, abundant water resources and abundant cheap labor force that can be exploited to produce quality and competitive horticultural product. Horticulture is diverse and caters for a wide array of activities, ornamental, medicinal herbs, environmental, social product and services which are all fundamental to development, maintenance of health and well-being and also a good source of income in combating poverty. In light of this there is a need to survey the horticultural activities of communities within the neighborhood of National Horticultural Research Institute, Mbato Out-Station with the specific objectives to determine the socio-economic characteristics of the respondents; to identify their awareness and horticultural crops produced and also to determine the constraints encountered in horticultural production in the study area

METHODOLOGY

The study was conducted within the neighborhood of National Horticultural Research Institute, (NIHORT),Mbato Out-

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Station,Okigwe, Imo State in 2018.Five communities (Aku, Agbobu, Umulolo, Umuowa-Ibu and Okigwe urban) that surround the institute were surveyed. The station is located on latitude 05^0 3^1 N, Longitude 07^0 23^1 E and 130m above sea level and rainfall average of 2300mm/annum.Both purposive and multistage random sampling techniques were adopted in selection of 64 farmers which made up the sample size. Primary data were collected using structured questionnaire from the sampled farmers. Data were analyzed with the use of statistical tools such as percentage and mean.

RESULT AND DISCUSSION

Result of data analysis in Table 1 shows that more females (51.6%) than males (48.4%) were sampled, with mean age of 40 years, which is in agreement with the findings of Fakayode et al., (2012) that majority of the vegetable respondents fall within the age bracket of 21-40 years indicating that there is a bright future for vegetable farming in the study area if, the potential of these youths are properly harnessed. Also it is an indication that most of the farmers are in their productive age, hence active participation in farming activities. Majority (78.1%) were married with average household size of 10 members indicating that they are responsible individuals, also, all (100%) of the farmers had one form of educational level or the other, however, secondary education was ranked highest with 45.3% which is an indication that most of the farmers are literate and thus enlightened and are aware of the importance's of horticultural production. More so, greater number (34.4%) had spent at most 10 years in production of horticultural crops which agrees with the findings of Mohammed and Afework (2016). The farmers cultivate a mean farm size of 1.3 hectare, a similar results were obtained by Mohammed and Afework (2016) which revealed that majority of fruit and vegetable farmers cultivate between 0.1- 5 hectare . They farmers in the areas were visited by agricultural extensionist (68.8%). Greater population (45.3%) of farmers got at most ₦30, 000.00 annually from production of horticultural crops, revealing that it is a good source of income.

Table 2, shows the analysis of data obtained from the survey with respect to farmers awareness and production of horticultural crops in the study areas, here all (100%) of the farmers were aware of the existences of orange, this was closely followed by awareness of okro (90.6%), pawpaw (89.1%), pineapple (89.1%),banana (85.9%), plantain (85.9%), mango (84.4%), maize (84.4%), and telfairia (ugu) (84.4%).Furthermore, greater percent of the sampled farmers were aware of such horticultural crops as garden egg (76.6%),cucumber (75%), tomatoes (67.2%), coconut (67.2%),pepper (67.2%), uziza (65.6%), bitter leaf (62.5%),watermelon (62.5%),cocoyam (64.1%),ukazi (60.9%), utazi (59.4%), pumpkin (54.7%), avocado (54.7%), oilbeam (54.7%), udara (54.7%), also,50% of the sampled farmers was aware of bitter cola and nobody was aware of chorchorus (ewedu) and asters flower, while only one person, was aware of araucaria flower. The various levels of awareness exhibited by the respondents could be due the closeness of the study areas to NIHORT out-station and also due to effective dissemination of information by the institute within its neighborhoods. Consequently, all (100%) of the farmers were into production of orange, okro (84.4%), this in agreement with the findings of Fakayode, (2012), that orange and okra are the most widely grown fruit and vegetable crops within their study area..Maize(84.4%),pineapple(84.4%),plantain(81.3%),pawpaw(78.1%) and telfairia (ugu) (71.9%), which were followed by

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production of mango (78.1%), banana (76.6%),pepper (73.4%),garden egg (70.3%), and uziza (62.5%). The various levels of involvement of the respondents in the production of these crops can be attributed to market demand, to its income generation capacity to supplement their meager income and also in meeting their family food needs. This agrees with the findings ofkamei (2013) that all kinds of horticultural crops are viable and earn an additional income to every household. Yet, majority of the households are not producing for market but only for self consumption and to earn just an extra-income for the family. And none (100%) of the farmers produced asters flowers and corchorus (ewedu) at all in the area. This could be attributed to the fact that there is no market demand for it within the study areas.

Analysis of data in Table 3 shows that all the mean score values obtained were all above decision level of 2.5 on 4 point likertscale assessing challenges, indicating that all the examined factors were notable challenges facing farmers in the area, however, inadequate finance, inadequate access to loan and lack of modern production practices as well as lack of storage and processing facilities were outstanding challenges averaging 3.45, 3.42, 3.35 and 3.34 respectively. This agrees with the findings of Alonso et al.,(2013) that growth in horticultural crops are constrained by lack of access to adequate and affordable credit and crop insurance, lack of adequate extension services etc. These were closely followed by factors such as pests and diseases attack, small available land, and poor produce prices with mean values of 3.31, 3.26 and 3.20 each. Other notable factors were high cost of farm inputs; unavailability of improved varieties of seeds as well as high perishability nature of produce averaged 3.17, 3.12 and 3.12 each. Similarly, Alemayehu,(2016) revealed that farmers are faced with a lot of problems such as abiotic (lack of pure planting materials, long chain marketing systems and adverse environmental factors) and biotic factors (fungus, bacterial and insects) on horticultural crop production. Likewise, pilfering (with mean value of 2.57) was merely observed as a challenge.The findings ofMadisa et al., (2012) stated that farmers are mainly constrained by different factors which include; pests, water and shortage of basic farm inputs like seed and fertilizers. They also have limited knowledge of the standard methods of production required to satisfy the genetic requirement of improved seeds and have insufficient access to the formal market. Madisa*et al*. (2010) and Seleka (1999) also ranked crop pests, lack of labour, water stress and poor management among the top constraints mentioned by farmers. Thus, all the sampled farmers agreed that they were seriously faced with the examined challenges.

CONCLUSION

Horticultural products play significant nutritional role in our everyday diet and from this study it can be observed that communities within the neighborhood of National Horticultural Research Institute, (NIHORT) Mbato Out-Station, Okigwe are aware and are into the production of horticultural crops even though faced with various levels of challenges.

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Table 1: Socioeconomic Characteristics of Farmers

Socioeconomic characteristics	Frequency	Percentages
Sex		
Male	31	48.4
Female	33	51.6
Age		
≤30	15	23.4
31-40	21	32.8
41-50	20	31.3
≥50	8	12.5
Marital status		
Single	14	21.9
Married	50	78.1
Separated	0.0	0.0
Divorce	0.0	0.0
Family size		
≤10	51	79.7
11-15	12	18.8
≥16	1	1.6
Level of education		
No formal education	0.0	0.0
Primary education	23	35.9
Secondary education	29	45.3
Tertiary education	12	18.8
Years of horticultural crops production		
≤10	22	34.4
11-15	18	28.1
16-20	12	18.8
≥21	12	18.8
Farm size		
≤0.5	20	31.3
0.6-1.0	11	17.2
1.1-1.5	16	25.0
1.6-2.0	10	15.6
≥2.1	7	10.9
Agricultural extension visits		
No	20	31.3
Yes	44	68.8
Annual farm income		
≤₦30,000.00	29	45.3
₦ 31,000.00- ₦ 40,000.00	16	25.0
₦ 41,000.00- ₦50,000.00	12	18.8
₦ 51,000.00- ₦ 60,000.00	1	1.6
≥ ₦61,000.00	6	9.4

Source; field survey data analysis, 2018

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Table 2: Awareness and production of horticultural crops in the study area

Awareness of Horticultural crops			Production of Horticultural crops	
Crops	frequency	Percentage	Frequency	Percentage
Orange (Citrus spp)				
No	0	0.0	0	0.0
Yes	64	100.0	64	100.0
Mango (Mangiferaindica)				
No	10	15.6	14	21.9
Yes	54	84.4	50	78.1
Garden egg (Solanum melongena)				
No	15	23.4	19	29.7
Yes	49	76.6	45	70.3
Okro (Abelmoschusesculentum)				
No	6	9.4	10	15.6
Yes	58	90.6	54	84.4
Irvingiaspp(ogbono)				
No	41	64.1	49	76.6
Yes	23	35.9	15	23.4
Breadfruit(ukwa)(Treculia Africana)				
No	33	51.6	59	92.2
Yes	31	48.4	5	7.8
Uda (Xylopiaaethiopica)				
No	48	75.0	52	81.3
Yes	16	25.0	12	18.8
Udara (African star apple)(Chrysophyllumalbidum)				
No	29	45.3	33	51.6
Yes	35	54.7	31	48.4
Uziza (Piper guineense)				
No	22	34.4	25	39.1
Yes	42	65.6	39	60.9
Pawpaw (Carica papaya)				
No	7	10.9	14	21.9
Yes	57	89.1	50	78.1
Banana (Musa spp)				
No	9	14.1	15	23.4
Yes	55	85.9	49	76.6
Tomatoes(Lycopersiconesculentus)				
No	21	32.8	31	48.4
Yes	43	67.2	33	51.6
Amaranthusspp(inne)				
No	37	57.8	41	64.1
Yes	27	42.2	23	35.9
Telfairiaoccidentalis (ugu)				
No	10	15.6	18	28.1
Yes	54	84.4	46	71.9
Cucumber (Cucumissativus)				
No	16	25.0	26	40.6
Yes	48	75.0	38	59.4
Bitter leaf (Vernoniaamygdalina)				
No	24	37.5	30	46.9
Yes	40	62.5	34	53.1
Oilbeam (Ukpaka)				
No	31	45.3	43	67.2
Yes	34	54.7	21	32.8
Avocado (Perseaamericana)				
No	29	45.3	37	57.8
Yes	35	54.7	27	42.2
Scent leaf (Occimumgratissium)				
No	33	54.7	36	56.3
Yes	31	45.3	28	43.8

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Water leaf (Talinumfruticosum)				
No	35	54.7	35	54.7
Yes	29	45.3	29	45.3
Walnut (Juglansregia)				
No	47	73.4	48	75.0
Yes	17	26.6	16	25.0
Curry (Murrayakoenigii)				
No	41	64.1	48	75.0
Yes	23	35.9	16	25.0
Ukazi (Gnetumafricana)				
No	25	39.1	31	48.4
Yes	39	60.9	33	51.6
Pumpkin (Cucurbita pepo)				
No	29	45.3	34	53.1
Yes	35	54.7	30	46.9
Grape (Citrus paradise)				
No	34	53.1	44	68.8
Yes	30	46.9	20	31.3
Pineapple (Ananascosmosus)				
No	7	10.9	10	15.6
Yes	57	89.1	54	84.4
Plantain (Musa spp)				
No	9	14.1	12	18.8
Yes	55	85.9	52	81.3
Coconut (Cocos nucifera)				
No	21	32.8	25	39.1
Yes	43	67.2	39	60.9
Pepper (Capsicum spp)				
No	21	32.8	17	26.6
Yes	43	67.2	47	73.4
Moringa (Moringaoleifera)				
No	39	60.9	47	73.4
Yes	25	39.1	17	26.6
Watermelon (Citrulluslanatus)				
No	24	37.5	26	40.6
Yes	40	62.5	38	59.4
Pear (Dacryodes edulis)				
No	26	40.6	26	40.6
Yes	38	59.4	38	59.4
Utazi (Gongronemalatifolium)				
No	22	34.4	33	51.6
Yes	42	65.6	31	48.4
Bittercola (Garcinia kola)				
No	32	50.0	38	59.4
Yes	32	50.0	26	40.6
Lemon grass (Cymbopogon)				
No	44	68.8	46	71.9
Yes	20	14.1	18	28.1
Long pepper(Piper longum)				
No	34	53.1	42	65.6
Yes	30	46.9	22	34.4
Melon (egusi) (Citrulluslanatus)				
No	33	51.6	27	42.2
Yes	31	48.4	37	57.8

Source; field data analysis, 2018

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Table 3: Mean scores of Challenges facing horticultural crops production

Challenges	mean	Standard Deviation
Inadequate finance	3.45	.50
Inadequate access to loan	3.42	.66
Small available land	3.26	.71
Lack of steady water supply	2.93	.92
Inadequate extension services	2.85	.77
Inadequate labour supply	2.70	.88
Unavailability of improved varieties of seeds	3.12	.60
Pests and diseases attack	3.31	.68
Poor produce prices	3.20	.59
Animals attack on crops	3.03	.77
Lack of modern production practices	3.35	.65
Changes in pattern of rainfall and other weather conditions	2.88	.81
High cost of farm inputs	3.17	.74
Lack of storage and processing facilities	3.34	.78
High perishability nature of produce	3.12	.78
Poor road networks	2.82	.91
Pilfering	2.57	.93

Source; field data analysis, 2018

Benefit - Cost Ratio of Fluted Pumpkin Production in Abia State, Nigeria.

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Abstract
Fluted Pumpkin [TelfairiaoccidentalisHook.F] is an important vegetable of which it's economic, nutritional and medicinal properties cannot be over emphasized. Based on its increased demand and production, the study analyzes the profitability of fluted pumpkin production in Abia State. Data were obtained with the aid of a well structured questionnaire from 60 vegetable farmers using a simple random sampling technique and analyzed using descriptive statistics and chi-square test. Results revealed that majority (80 %) of the respondents were women; 81.67% were aged 31-61 years;83.33 % were married, 40 % had farming experience of 1- 10 years and 68.33 % had family sizes of about 6 –10 persons. Pumpkin farmers had a Gross Margin and Net Income of ₦1, 073,975and₦701, 245 respectively. The profitability ratios BCR and ROI were found to be 1.44, 0.31 and 55.82 respectively, indicating that vegetable production was profitable in the area. The Chi-square test result showed that age, sex, years of farming experience, family size and labor cost were variables that significantly influenced the benefit and cost ratio of fluted pumpkin production in the study area. Hence, effort should be directed towards encouraging the productionof fluted pumpkin due to its profitability and also ensuring credit and farm input availability through the provision of soft and lowinterestloan.
Keywords: Cost, Profitability, Fluted Pumpkin, Return on Investment, Benefit and Cost Ratio.

INTRODUCTION

Fluted pumpkin (*Telfairiaoccidentalis Hook F.*) is an important agricultural crop not only because of its economic importance but also due to the nutritional and medicinal value and also being an excellent source of antioxidant compounds (Alada, 2000; Dina *et al*.,2006). Fluted pumpkin is the most important and extensively cultivated food and income generating crops in many parts of Africa (Adebisi-Adelani*et al*., 2011). It is one of the most important vegetable and mostly produced while providing essential vitamins and minerals. The nutritional potentials of fluted pumpkin merits special attention. It is a rich source of protein (29%), fat (18%), minerals and vitamins (20%) (Ndor*et al*., 2013). Fluted pumpkin has the potential to regenerate testicular damage and increase spermatogenesis due to the presence of many vitamins, minerals and essential amino acids (Nwangwa, *et al.,* 2007;Agbugba*et al*., 2011). In many households, bland diet should contain 250-325g of vegetables and the average human requirement for vegetable is 285g/person/day for a balanced diet (Olugbemi, 1989;Attavar, 2000). Alada, 2000; Dina, *et al.* (2006) pointed out, in addition to the uses of fluted pumpkin as food, that fluted pumpkin is used for condiment and medicine as well as ornamentals in gardens. Akinsami, (1975); Schippers, (2000) pointed out that fresh shoot yields is usually about 500-1000kg/harvesting/ha, but could be more if the crop receives adequate manure or when fertilizers are applied after each picking. However, Fluted pumpkin is produced in Nigeria and the major area of production is South Eastern Nigeria (Akoroda, 1990). High potential fluted pumpkin producing areas of Nigeria such as Southeast and Southwest parts (most of which also lie within the tropical rainforest zone) produce enough to meet the needs of the people in thedeficit areas. Although, fluted pumpkin is widely cultivated in Nigeria, yields obtained by small scale farmers are often very low (Awoyemi, 1981).

Abia state fluted pumpkin production is climatic condition and day length

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connected though it survives drought and can retain its life in the root even after many years, soil moisture content has important effects on the growth and yield of the crop. In general, fluted pumpkindoes best at the lower altitudes and medium to high rainfall and will do well on sandier soil provided fertilizer is applied but has a more robust growth in rich well drained soil.

The average human requirement for vegetable is 285g/person/day for a balanced diet and its consumption necessary because of its essential amino acids, antioxidant and medicinal properties (Olugbemi, 1989;Attavar, 2000). It is extensively consumed in the daily diet of over 120 million Nigerians irrespective of their socioeconomic status. It is used in the preparation of soup and stew, which are among the major essential complements of staple foods based on cereals and root crops and also used for the treatment of sudden attack of convulsion, malaria, and anaemia; it also plays a vital and protective role in cardiovascular diseases (Alada, 2000; Dina*et al.,* 2006).

Therefore, the aim of the study is to evaluate the benefit - cost ratio of fluted pumpkin production among farmers inAbia State; while also assessing the factors influencing the production of this vegetable in the study area.

METHODOLOGY

Study area

The study was conducted in Abia State. The present day Abia state has seventeen (17) local government square km and a population of 2,833,999 inhabitants (NPC, 2006). Agriculture as the second economic sector contributes areas with coordinates of $5^{o}417^{'}$N and $7^{o}500^{'}$E of the Greenwich meridian covering a total area of 6,32027% of the state's Gross Domestic Product [GDP] and employs 70% of the state workforce with greater population living in the rural areas. The state is agrarian with three agricultural zones viz: Aba, Umuahia and Bende. With its adequate seasonal rainfall and much arable land, the climate favors' the growth of different food and cash crops. The major crops grown in the study area include; yam, cassava, cashews, maize, pineapple, vegetable crops, plantains, oil palm, rubber etc.

Sampling Procedure and Data Collection Method

Primary data used was collected through a multi- stage sampling technique. The first stage involved the selection of one local government area each from the three agricultural zones. The selected local governments were Bende, Ikwuano and IsialaNgwa North Local government areas respectively. Three villages where fluted pumpkin is grown extensively were randomly selected from the three selected Local Government Areas in the ratio of one per Local Government Area (1:1). In the second stage, Uzuakoli village was chosen from Bende, Oboro from IkwuanoandUmuodeNsulu in IsialaNgwa North. In the third stage, 20 fluted pumpkin farmers were selected in each of the villages with the help of key informants from a compiled list of fluted pumpkin growers in the area, making a total of 60 respondents. A well structured questionnaire was administered to elicit information from the farmers.

Method of Data Analysis

The data collected were analyzed using both descriptive statistics and chi square test. Analysis of costs and returns was used to estimate the costs and returns while gross and net margins as well as rate of return on investment were used to measure benefit - cost ratio of fluted pumpkin production in the study area. Chi-square was used to analyze the relationship between the socio-economic variables as they affect fluted pumpkin production.

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RESULTS AND DISCUSSION

Socio Economic characteristics

The socio economic characteristics of vegetable farmers involved in the study are presented in table 1. This shows that there are more women (80 percent) involved in fluted pumpkin (*Telfairiaoccidentalis*) farming than men in the study area, with majority of them in their economic active age between the ages of 31 and 50 years. This implies that there would be a sustainable increase in fluted pumpkin production in the area. This agrees with the findings of Rahman *et al*.(2002) which showed that farmers' age may influence adoption in several ways. Most (83.33%) of the vegetable farmers in the study area were married with majority (68.33%) of them having a household sizeof 6 persons and above. This agrees with the findings of Oladoja, *et al.* (2008)and Subba – Reddy *et al.*(2004)who contended that marriage is an important factor in the livelihood of individuals in our society as it is perceived to confer responsibility on individuals andalso stated that household sizes have been noted to affect family labor available for farm work and other household activities respectively. Vegetable farmers in the study area were well educated with 96.66 % having attained at least primary education. With 60 percent of the respondents having experience years of 6 and above, this implies that the farmers are well grounded in the techniques of fluted pumpkin farming. It could be observed that the respondents had relatively large household sizes made up of between 6-10 persons with about 68.33 percent of the respondents falling into this category. The implication of this is that most respondents have large families. Family size is an important index in any rural development intervention which can affect the outcome of such intervention (Banmeke, 2003). Majority of the farmers are low income earners in terms ofmonthly income generated from fluted pumpkin sales.Frequency of harvest affects fluted pumpkin production, from the data collected, 61.67% harvested more frequently than others. This implies that moderate harvest of four times will increase farmers' income and will not have negative effect on the growth and performance of fluted pumpkin.

Production Cost and Returns Analysis

The production cost and returns analysis of fluted pumpkin is presented in Table 2. Total revenue of ₦2, 288,610.00 was realized per hectare of fluted pumpkin. The total cost of ₦1, 587,365 was incurred. Of this, variable cost constituted about 76.52 % (₦1, 214,635) of total cost of pumpkin production. Further analysis of thevariable cost component showed that labor accounted for 88 %, pesticide 8.6 % and planting material 1.3% of total variable cost of production. Agross margin and Net Income of ₦1, 073,975and₦701, 245were realized per hectare.

The ratios calculated to establish the profitability of fluted pumpkin production were the Benefit - Cost ratio and Return on Sales. Based on the result as revealed in table 2, the Benefit - cost ratio of 1.44 shows that the business is profitable, hence for every ₦1 invested in fluted pumpkin business,a yield of about ₦ 1.44kobo is expected in return. The average Profit Index for the enterprise was 0.30, indicating that out of every ₦1 earned about 30 kobo accrues to the farmer as net income. The ROI of 55.82% indicates that the vegetable farmer earns ₦55.82 profits on every ₦1spent in fluted pumpkin production. This agrees with the findings ofAdeoye*et al*.(2009) and Obinaju*et al.* (2015) that the business is of much economic rewarding in terms of profitsand with average Profit Index (PI) of 0.29 and RORI of 42.61%, about 29 kobo accrues to the farmer as net income and the fluted pumpkin farmer therefore earns ₦42.61 profit on every ₦1 spent on fluted

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pumpkin production respectively.Generally, it was noticed that fluted pumpkin (*Telfairiaoccidentalis*) production is profitable in the study area.

Chi-Square Test analysis showing the relationship between Socio economic Characteristics of Farmers involved in Fluted pumpkin (*Telfairiaoccidentalis*) Production

The Chi-Square test analysis showing the relationship between socio economic characteristics of farmers involved in Fluted pumpkin (*Telfairiaoccidentalis*) productionis presented in Table 3. The results revealed that the variables; sex, age, years of farming experience, family size and labour cost of respondents were the socio economic factors that influenced fluted pumpkin production among vegetable farmers.

Sex and years of farming experience were significant at ($P \leq 0.001$)while age, family size and labor cost were significant ($P \leq 0.05$). This implies that the female gender has a positive and strong influence on fluted pumpkin production in the three Abia State agricultural zones. Age and years of farming experience that was significant implies that farmers had vast knowledge over time in terms of technique; best cultural practices, strength, appropriate herbicide/chemical, timing and harvesting method that will increase fluted pumpkin production. Family size and labor cost indicate easy accomplishment of all farm work based on the largehousehold size i.e. a larger household size positively influences fluted pumpkin production. Also, labour cost was positive and significant indicating that a higher wage positively influences fluted pumpkin production. The larger the family size, the easier the farmwork and decrease in hired labor and increase in production while decrease in family size will lead to increase in paid laborincreased cost of production and decrease in profit margindecrease in farm net income.

However, farm size, fertilizer cost and seeds/pods cost were some of the socio economic variables that did not influence fluted pumpkin production among the respondents in the three agricultural zones of Abia State.

CONCLUSION AND RECOMMENDATIONS

The study examined the cost and benefit ratio of fluted pumpkin production in Abia State, Nigeria. The summary statistics revealed that fluted pumpkin production was dominated by literate farmers (96.66 %), majority were females (80 %) with average household sizeof 7 persons.The dominant age group and labor sources were 41-50 years [36.67 percent] and family labor 63.3 percent respectively. The Chi square test results revealed that the variables; sex, age, years of farming experience, family size and labor cost of respondents were the socio economic factors that influenced fluted pumpkin production among vegetable farmers in the study area. Farmers had a Gross Margin and Net income of ₦1, 073,975 and ₦701, 245 respectively. With profitability ratios ofBCR 1.44, ROI 55.82% and ROR of 0.306% which implies that pumpkinproduction is profitable. Based on the findings of this study, it is recommended as follows: Due to the huge fluted pumpkin production from rural areas, provisions should be made to ensure timely access of farm inputs. People should be encouraged to go into pumpkin production because of its high yielding and profitability.Since fluted pumpkin production is still practiced on typical subsistence type of agriculture, it is recommended that large expanse of lands should be acquiredand leased out to vegetable farmers at reduced rates and with less stringent conditions by government and Non Governmental Organizations to enhance fluted pumpkin production.

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Table 1: Socio – Economic Characteristics fluted pumpkin farmers [n=60]

Age	Frequency	Percentage
21-30	11	18.33
31-40	17	28.33
41-50	22	36.67
51-60	9	15.00
61 and above	1	1.67
Mean	40.75	
Standard deviation	12.04	
Sex		
Male	12	20
Female	48	80
Marital Status		
Single	4	6.67
Married	50	83.33
Widowed	6	10.00
Family size		
1-5	17	28.33
6-10	41	68.33
11-15	2	3.34
Mean	6.75	
Educational Status		
No Formal Education	2	3.34
Primary Education	5	8.33
Secondary Education	21	35.00
Tertiary Education	27	45.00
Adult Education	5	8.33
Monthly Income from Telfairia Farming		
Below ₦20000	28	46.67
₦ 20,001 – ₦ 30,000	14	23.33
₦ 30,001 – ₦ 40,000	12	20.00
₦ 40,001 – ₦ 50,000	4	6.67
₦50,001 and Above	2	3.33
Years of Farming Experience		
1 –10	24	40.00
11- 20	20	33.33
21- 30	13	21.67
31 and Above	3	5.00
Mean	13.67	
Farmers source of labor		
Hired	22	36.7
Family	37	63.3
Farm Size(ha)		
0.1 – 0.3	14	23.33
0.4 – 0.6	37	61.67
0.7 – 0.9	9	15.00
1.0 - 1.2	-	-
1.3 – 1.7	-	-
Mean	0.48	
Number of Harvest times		
1 – 2	20	33.33
3 – 4	37	61.67
5 – 6	3	5.00
Mean	2.93	

Source: *Field survey, 2016*

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Table 2: Production Cost and Returns Analysis of fluted pumpkin production

Items	**Units**	**Value[₦]**
Revenue items		
Value of output	Kg	2,288,610
Total Revenue	Naira	2,288,610
Cost items		
Variable Cost		
Labor Cost	Manday[s]	434,300
Fertilizer	Kg	275,035
Pesticide	Liters	183,100
Transport		92,200
Planting materials		230,000
Total Variable Cost		1,214,635
Fixed Cost		
Bags		38,900
Rent on land	Hectare	132,500
Basket		37,030
Hoe		82,600
Cutlass		79,700
Total Fixed Cost		372,730
Total Cost[TVC+TFC]		1,587,365
Gross Margin[TR-TVC]		1,073,975
Net Income[GM-TFC]		701,245
Profit Ratios		
Benefit Cost		1.44
Rate of return		0.3064065
Return on investment		55.82

Source: *computed by author using data from field survey, 2016*

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Table 3:Chi-square test analysis of the relationship between socio economic characteristics of farmers and Fluted pumpkin production

Variables	Coefficients	Df	P-value
Sex	12.56	4	0.014***
Age	28.96	16	0.024**
Years of farming experience	17.00	8	0.013***
Family size	17.73	8	0.023**
Farm size	54.64	62	0.735
Cost of fertilizer	18.63	25	0.814
Cost of pods/seeds	72.55	75	0.559
Labor cost	164.66	132	0.028**

Source: *Field survey, 2016*
*** Significant at 1%
** Significant at 5%

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Effect of improved Okra variety (NHAe47-4) on the Economic Status of Farmers in Ido Local Government Area of Oyo State

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Abstract

The study examined effect of improved okra variety (NHAe 47-4) on the economic status of farmers in Ido Village in Ido Local Government Area of Oyo State. The study was conducted by using supervised enterprise project approach to agricultural extension. Farmers in the study area were selected using purposive sampling method and they were made to form a group comprising twelve (12) members based on their active participation in vegetable farming in the study area. Descriptive statistical tool such as frequency distribution and percentages was used to analyze the objectives. At the end of the harvesting and whole exercise, the group (farmers) was interviewed verbally to know their levels of awareness for adoption and their general view about the improved variety in relation to the normal okra variety they were used to. The farmers embraced the technology and actively participated through demonstration method exercise. Having known all the techniques involved in the production cycle, the farmers also tried the technology on their individual plot which served as an encouragement factor for adoption. The study thus resulted into improving the standard of living and economic enhancement of the farmers in the study area.

Keywords: Okra, varieties, economic enhancement, farmers, Ido village

INTRODUCTION

Young immature okra fruits are important fresh fruit vegetable that can be consumed in different forms. They could be boiled, fried or cooked. In Nigeria, okra is usually boiled in water resulting in slimy soups and sauces, which are relished. The fruit also serves as soup thickeners (Schippers, 2000). The leaves buds and flowers are also edible. Its seed could be dried and be used to prepare vegetable curds, or roasted and ground to be used as coffee additive or substitute. Okra mucilage is suitable for medicinal and industrial applications. It has been medicinal as a plasma replacement or blood volume expander. Industrially, okra mucilage is usually used to glace certain papers and also useful in confectionery among other uses (Markose and Peter, 1990).

Modern agriculture requires that farmers should use scientific knowledge in the production of okra. In Nigeria, a lot of technological innovations to improve agricultural yields are available, but these technological innovations could not be accessed by the farmers who would make use of them. Farmers' major problem is the dependence on the use of local or traditional varieties that gives very low yield and poor in protein quality. Hence, the need for the introduction of high yielding improved variety of okra *(NHAe 47-4)* (Adeboye and Oputa, 1996; Iremiren and Okiy, 1999).

The introduction of *NHAe 47-4* variety is to help farmers to improve and increase okra production in the study area. This will in turn increase their income, improve their standard of living and meet the demand of the consumers. The main objective of this study is to introduce improved okra variety *(NHAe 47-4)* to farmers in the study area with a view to create awareness of improved okra variety *(NHAe47-4)*, acquaint the farmers with the new agronomic practices involved and to determine the performance of the improved okra variety *(NHAe 47-4)* in relation to those traditional okra variety (*Abelmoschus caillei*) which farmers were used to in the study area.

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MATERIALS AND METHODOLOGY

The study was carried out at Ido local government area of Oyo State, with headquarter at Ido town. The local government area shares boundaries with other Local Government Areas such as Oluyole, Akinyele, Ibarapa East, Ibarapa North West, Ibarapa South West of Oyo State and Odeda local government in South of Ogun State. The entire area is located in the forest region of Nigeria. The study area experiences two seasons (wet and dry) which allows the practice of both dry season and rain-fed cropping. Crops grown include fruits, vegetables, maize, cassava, yam, and plantain at various times of the year. Ido local government area of Oyo State occupies a total land mass of about eight hundred square kilometres (800sq.km) and the population is fifty two thousand, five hundred and eighty two (52,582) people (NPC 2006). The major occupation of the people in the area is farming, while alongside other vocational jobs, food vendors, livestock farming being practiced.

Descriptive statistics such as percentage and frequency distribution was used to analyse the data. A target group comprising twenty (20) farmers was formed based on the information gotten from the community leaders. This group was later purposively streamlined into twelve (12) volunteered farmers who were actively participating majorly in okra production. These farmers were introduced to the production of *NHAe 47-4* and its agronomic practices. The study was not an experimental, but an action research because no experimental designed method was involved. The techniques employed includes: group formation, demonstration plot training and awareness campaign exercise.

Demonstration plots

A demonstration plot with a layout of 10m x 15m dimension was established and was dedicated to the group where all training processes took place. The use of demonstration plot has enhanced the extensive uses of their senses and skills which improved their knowledge on agronomy activities of NHAe 47-4 okra variety.

Size of Farmland Devoted to okra Production

Table 1: shows that 8.33% of the respondents devoted 0.5-1ha of the farmland to okra production, 25% devoted 0.5ha, and only 0% devoted 1.5-2ha, while 66.67% accounted for others of the total farm land for okra production. This result shows that the total farmland of the respondents could affects the speed of NHAe 47-4 okra adoption and it agrees with the result of Manfield (1968) who reported that the total farmland contributes to technologiesdoption.

Improved varieties of seed used before NHAe 47-4 okra variety

Table 2: It was observed that 75% of the vegetable farmers within the community made use of improved okra variety, while 25% still go by the local variety due to their low source/ financial income which prevented them from obtaining necessary input.

Table 3: below shows that 50.00% of the respondents adopted NHAe 47-4 okra because of its high yield, 41.67% adopted it because of rapid growth, while 8.33% did not adopt the variety for the reason best known to them.

Level of adoption

Table 4 revealed the reaction of farmers after seeing the results of the demonstrations in terms of yields obtained. This was a result of the strict observance of the recommended practices demonstrated as follows:

- Land clearing – After clearing the demonstration plot, farmers undertook clearing of their own fields to prove the demonstrator's recommendation.

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- Ridging – The recommended form of making ridges was accepted, compared to former way of making their ridges for planting which made some operations difficult to be carried out for effective output.
- Improved seed and seed treatment – They used their local varieties. Although they (local varieties) were affordable but it was discovered that their yields were not as higher as that of the improved okra varieties. Farmers discovered that treated seeds had about 100% germination rate with vigour unlike old okra varieties, which gave about 65% - 70% germination rate with less vigour and requires planting supplementation.
- Planting time – it was recommended that planting should be done at appropriate time so as to reduce infestation of diseases.
- Seed rate – farmers discovered that, their seed rate per hole was too much and so resolved to be using recommended seed rate.
- Plant spacing – Close spacing was believed to give crowded plant population and reduced the size of the okra pods, therefore recommended spacing was adopted.
- Weeding – it was recommended that weeding should be done regularly to avoid nutrient competition between the crops and weeds.
- Use of herbicide – the group had known the use of herbicide on the field for clearing grasses before cultivation. This helps to add more nutrient into the soil as nothing is burnt or packed before ridges were made.

Awareness of NHAe 47-4 okra

After the completion of this project, all group members were interested in the variety and were extended to the entire farmers in the village and most the farmers became aware of the variety due to its value and other superiorities such as early maturity and high yield. Others are production practices.

NHAe 47-4 Okra farmers that indicated early maturity

Table 5: shows that all members of the group (100%) agreed that NHAe 47-4 okra variety is early maturing than other variety that they were used to as compared by the number of days to maturity.

Summary

Agriculture as an industry of managing the growth of plants and animals played a vital role in the sustenance of a country's economic growth and human use. The supervised Enterprise Project (SEP) was implemented to disseminate recommended improved okra variety (*NHAe47-4*) for okra production in the study area.This project was carried out to introduce *NHAe47-4* okra variety to vegetable farmers in Ido Village in Ido Local Government Area of Oyo State. The area of study is located within the high agricultural area of Ibadan, Oyo State.The main objective of the project was to introduce improve okra variety (*NHAe47-4*) to farmers in the study area through the adoption of recommended agronomic practices. This objective was seen to help the farmers out of their agricultural production stagnation tendencies so as to improve farmers' income generation.Awareness creation was made among the farmers and a group of farmers was formed. The targets of 12 members of the group formed were involved in the demonstration. Interview, group discussions and physical contact were used to collect primary data, while secondary data were obtained from published literature.The study revealed that 75% of the farmers within the locality have been

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practicing the use of improved seeds which does not give doubt in the introduction of *NHAe47-4* okra variety.The general concession was that the performance of the demonstration of one general plot and that of individual on *NHAe47-4* showed that it is early maturing than normal okra and yield higher than the normal okra.

CONCLUSION ANDRECOMMENDATION

Generally, it was observed that before the introduction of the innovation of *NHAe47-4* okra variety to selected farmers in the study area, they had used to communal and traditional practices and methods in carrying out their farming activities most especially for okra production. The introduction and adoption of an improved (*NHAe47-4* okra) variety boosted their production level more than those that planted the ordinary okra variety that they were used to. Therefore, adopting and effective use of recommended agronomic practices orchestrated by this innovation would engender good crop performance and ensure high crop yield per unit area. Likewise, continuous sensitization, awareness creation, group formation and regular field days were responsible for easy adoption of the technology among the vegetable (okra) farmers in the study area.

Hence, it is recommended that extension workers should be adequately trained on the use of improved varieties of crops. Also, agricultural shows or field days should be introduced in the State to serve as a medium for demonstrating the results of improved practices to farmers.More enlightenment campaigns should be embarked upon to reach more farmers with the new approach to okra production and the importance of vegetables in general.

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Table 1: Distribution of Respondents According to Farmland devoted to okra Production

Farmland for okra	Frequency	(%) Distribution
0.5ha	3	25.00
0.5-1ha	1	8.33
1-1.5ha	-	-
Others	8	66.67
Total	12	100.0

Table 2: Distribution of Respondents that used other improved seed before NHAe47-4

Adoption	Frequency	(%) Distribution
adopted	9	75.00
Non adoption	3	25.00
Total	12	100.0

Reasons for Adopting NHAe 47-4 okra variety

Table 3: Distribution of Respondents According to Reasons for Adopting NHAe 47-4

Reasons	Frequency	(%) Distribution
Resistance to diseases and Pests	-	0
Low Fertilizer requirement	-	0
Rapid growth	5	41.67
Better yield	6	50.00
Non Adopters	1	8.33
Total	12	100.0

Table 4: Level of adoption of recommended practices

Reasons	Frequency	(%) Distribution
Land clearing -	12	100
Ridging -	12	100
Use of improved seed	12	100
Seed treatment	12	100
Planting date	12	100
Seed rate	12	100
Plant spacing	12	100
fertilizer application	12	100
Weeding	12	100
Use of herbicide	12	100
Total	12	100.0

Table 5: NHAe 47-4 Okra farmers that indicated early maturity

	Frequency	(%) Distribution
Late maturing	Nil	-
Medium maturing	Nil	-
Early maturing	12	100
Total	12	100.0

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Determinants of Profitability of Fresh Maize Marketing in Lagos State, Nigeria

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Abstract
The study investigated the determinants of profitability of maize marketing in Ikorodu Area of Lagos State. Ninety respondents were randomly selected from among the sample frame. Primary data were collected through questionnaire administration. Marketing margin analysis was used to determine the profitability whereas multiple regression analysis was adopted to analyze the effects of socio-economic factors on marketing income. The result shows that most respondents (49.53%) were within the age range of 31 and 40 years indicating that maize marketing was dominated by young people. An overall coefficient of marketing efficiency of 86% was recorded by the farmers who markets the maize produced from their farms to retailers. The coefficient of determination (R^2) of 0.824 implies that 82.4% of the variation in maize marketing income is explained by age, marital status, education, access to credit, gender, marketing experience and marketing cost. Age of the respondents was positively related to marketing income, but insignificant at 5% level of probability. Marital status affects fresh maize marketing negatively but was not significantly different from zero. Access to credit is also positively. However, results of the regression analysis show that access to credit was not a significant determinant of marketing income. Level of education was negatively signed and not statistically significant. Marketing cost was however positively related to marketing income, contrary to apriori expectation.
Keywords: *Market structure, marketing efficiency, profitability, wholesalers, retailers, Lagos State*

INTRODUCTION

After wheat and rice, maize is the most important cereal in the world (Fakorede *et al*., 2003). It is a major staple food grown in all parts of Nigeria, and has become an important item of diet for human beings and livestock. It provides energy and vitamins, and the negligible amount of protein. Output of maize has continued to increase in Nigeria. In Nigeria, maize has now risen to a commercial crop providing raw materials to agro-based industries. Its consumption accounts for about 64% of the total daily calorie intake of rural dwellers especially during the hunger time. There is no class distinction in maize consumption and there are no apparent taboos or religious sentiment associated with its production, preservation and utilization (Okafor, 2004.

It is increasingly apparent that the broad objective of achieving agricultural productivity and improving household food consumption should be balanced by policies to improve market access (Haggblade, 2004). Thus the question of increasing the market participation of smallholder farmers remains pertinent to improving their welfare (Holloway *et al.*, 2005).

Fafchamps *et al.* (2003) noted that maize constitute 50 to 60 per cent of the per calorie consumption of Nigerians. Low level of domestic production, poor storage facilities and inconsistent trade policies has been found to be largely responsible for insufficient market supply of maize (Onu and Illiyasu, 2008). To assess the market performance and determine the market efficiency, there is the need to estimate the market margins of the intermediaries, such as wholesalers and retailers. Studies (Adekanye, 2008; Ikpi, 2011) have shown that the marketing margins are high for food crops in South Western Nigeria, as the prices paid by consumers are not commensurate with the level of satisfaction they derive from the consumption of these commodities. Again, Asante (2003) noted that high

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transportation costs of farm produce from the farms to the market places occasioned by poor conditions of rural roads and poor storage facilities often lead to high market price of maize. These and many other factors hinder effective marketing of maize.

Marketing entails all processes involved from the production of a commodity until it gets to the final consumer (Crammer *et al.*, 2000). These processes ensure that the right product (form utility) is available at the right place (place utility), at the right price (possession utility), and at the right time (time utility) to fully satisfy the consumer (Beierlein and Woolverton, 2001; Okoh *et al*., 2008). It enables producers such as farmers as well as middlemen to earn income with which they purchase other useful goods and services (Ebe, 2007). The ability of the marketing system to allocate gain over space and time has been a serious problem in agricultural marketing. CBN (2001) while commenting on post-harvest pricing and marketing, suggested that agriculture, like any other private enterprise, is propelled by entrepreneurs who are motivated by profits from their investments and entrepreneurship. Therefore, in order to ensure maximum returns, farmers must make his production decisions considering the most favourable place, time and form in which his product could be marketed. Geographical barriers separate agricultural commodities and the consumers of such commodities. Hence, the need to develop a marketing system that will connect the areas of production and consumption of agricultural products becomes very vital. Meadows (2004) asserted that the low supply at the end of the farming season is passed on to the public at relatively high prices, and identifies it as one of the factors that militates against food security in Nigeria.

However, looking at the nature of agricultural supply, most farm products will require the addition of some of the marketing services performed by the middlemen before they can satisfy the wishes of the consumers in form, time and place. These services may be in the form of grading, packaging, storage and further processing. Thus they must be performed at some degree prior to the time of final consumption. Therefore, the product in demand by the consumer at the retail level is a different product from that which is available at the farm. This difference may be attributed to time, place or the form that the products are. The difference between the price at farm-gate and the price in the market place during the year represents the payment to the owner of the grain storage facility and to those persons who assume the risks of price changes (Ihimodu, 2003). Furthermore, the market intermediaries add value to the grain in distribution, and thus the services involved labour, time and capital which cost the farmers and consumers some money. The costs are been borne by the middlemen who are often alleged of exploiting the farmers and the consumers. This paper assessed the socio-economic analysis of fresh maize marketing in Ikorodu Local Government Area of Lagos State.

METHODOLOGY

Ikorodu Local Government in Lagos State was used as the study area. The area is located along the Lagos Lagoon. It shares a boundary with Ogun State. As of the 2006 Census, Ikorodu had an estimated population of 535,619, land area of 394 square kilometers. The population for this study was maize marketers. Respondents who act as marketers by selling their product fresh to middlemen, retailers and consumers were sampled. Primary data with the use of structured questionnaire were collected based on the socio-economic variables. Ninety respondents were sampled.

Analytical procedure

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Regression Analysis: Multiple regression analysis following Lucey (2004) was adopted to x-ray the effects of socio-economic factors on marketing income, and is implicitly specified as

MI = f (AGE, MST, EDU, ACC, GEN, MKE, MKC, U).

Where:

- MI = Marketing income (₦).
- AGE = Age of maize marketer (years)
- MST = Marital status (Dummy: married=1, single=0)
- EDU = educational level (years)
- ACC = Access to credit (Dummy: accessed credit=1, otherwise=0)
- GEN = Gender of maize marketer (Dummy: male=1, female=0)
- MKE = Marketing experience (years)
- MKC = Marketing cost (₦)
- U = Stochastic or error term

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The results in Table 1 shows that majority of the maize marketers (49.53%) were within the age range of 31 and 40 years. This implies that, maize marketing in the study area was dominated by young people. This may be because the business requires a lot of energy and is labour intensive, moving from one place to another to assemble the products for marketing..

Table 1 also shows that majority of the respondents (65.6%) were female. Thus, the business is dominated by female. The table further indicates that majority (67.8%) of the maize marketers were married. This suggests that maize marketing in the study area is dominated by married couples. This may arise from the fact that maize marketing is a profitable venture, which can serve as a reliable source of livelihood for the family. The result further shows that majority (44.4%) of the respondents had secondary education while 27.8% have tertiary education. This result suggests that almost all the respondents were literate enough to give room for effective communication in doing their maize marketing business.

Determinants of maize marketing income

The multiple regression analysis involved running three functional forms namely: linear, semi-log, and double-log and the one with the best fit in terms of signs of the coeficient, magnitude, coefficient of determination (R^2) and F-ratio as the lead equation, thus, the double-log equation model was chosen and the result for the marketing income function is presented in Table 2

The coefficient of determination (R^2) of 0.824 implies that 82.4% of the variation in maize marketing income was explained by age, marital status, education, access to credit, gender, marketing experience and marketing cost. The F-ratio is statistically significant at 5% level of probability, further confirming the overall significance of the parameter estimates in the relationship. Age and marital status of the marketer were positively related to marketing income, but insignificant at 5% level of probability. The reason could be that married marketers would have accumulated experience and resources to enable them excel in the business. More so, results of the regression analysis also show that marketing positive relationship with marketing income and is significant. Access to credit is also positively experience has related implying that marketers who have large resources will sell more fresh maize and realize more income than those with small capital. Level of education is negatively signed but statistically significant. Thus, marketing income was influenced by the number of years spent in formal education. Marketing cost was positively related to marketing income, contrary to apriori expectation.

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Results of the regression analysis show that marketing cost was a significant determinant of marketing income.

Challenges to effective Maize Marketing

The problems of food (maize) marketing as given by the respondents in the study area are detailed in Table 3. Since there are multiple responses, the problems are ranked according to the percentage of respondents who mentioned them. From the result in Table 3, the most pressing challenge facing maize marketers in Ikorodu area of Lagos State was seasonality of the produce (51.1%). The seasonal pattern of production of maize creates some problems. The seasonality creates surpluses at harvest period, which must be sold at low prices, or stored for future sale at greater costs. At off-season there is shortage of the products, which leads to a gap in the supply-demand situation and high fluctuations in prices for food crops in the country. Next to fluctuation in maize supply is the incessant high cost of maize, especially during off-season period. This leads to low returns and inefficient marketing process. Lack of a central maize market in Ikorodu also posed a significant challenge for marketers as they have to comb the entire area in search of maize supply .Transportation problem (22.2%) is another major problem of maize marketing identified in this study. Transport facilities are grossly inadequate. This makes transportation cost to account for a very high percentage of the marketing costs.

CONCLUSION AND RECOMMENDATIONS

The study showed maize marketing to be very profitable. And to improve maize marketing so as to increase food production and enhance the prospect of food security in Nigeria, some recommendations are suggested.

There should be provision of adequate transportation facilities. This will entail the construction, expansion and maintenance of roads. Good network of feeder roads should be constructed either by the government or communities linking rural areas for easy transportation of maize produce since the product is bulky and vulnerable and this will reduce the transportation cost as complained by the marketers. Government should create a conducive environment that would encourage private vehicle owners to set up commercial transportation services. Duties on new vehicles and spare parts should be reduced to make them affordable to intending transporters.

Secondly, there is the need for the provision of basic market facilities like storage facilities, health facilities, communication facilities, banking facilities, water supply, fire service and security services. Market associations, individuals and non-governmental organizations could provide these facilities. Food marketers should also form market associations and marketing cooperative societies so that they can pool resources together and obtain credit from banks and other financial institutions for bulk purchasing and marketing.

Finally, there should be increased investment in post-harvest technology research and development. In this regard, simple storage and processing equipment could be developed which can be used at the level of the farmers and marketers, so as to reduce post-harvest food losses in Nigeria.

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Table 1: Socio-economic characteristics of the respondents

Variables	Categories	Frequency	Percentage
Gender	Male	31	34.4
	Female	59	65.6
Age (Years)	Below 30 years	17	18.9
	31 – 40 years	35	38.9
	41 – 50 years	32	35.6
	51 – 60 years	6	6.6
	No formal education	6	6.7
	Primary education	14	15.6
	Educational Background	40	44.4
	Tertiary education	25	27.8
	Adult education	5	5.6
	Single	21	23.3
	Married	61	67.8
	Widow(er)	8	8.9
Family size	1-4 persons	56	62.2
	5-10 persons	32	35.6
	11-15 persons	0	0.0
	16-20 persons	0	0.0
	Above 20 persons	2	2.2
Marketing experience	1 – 5 years	54	60.0
	6 – 10 years	28	31.1
	11 – 15 years	7	7.8
	16 – 20 years	1	1.1
Average Monthly Income	N1,000 - N50,000	65	72.2
	N50,001 - N100,000	13	14.4
	N100,001 - N150,000	10	11.1
	N150,001 - N200,000	2	2.2
Access to Credit	Yes	34	37.8
	No	56	62.2

Source: Field Survey, 2015

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Table 2: Estimates of factors influencing marketing income of maize marketers (N=90)

	Standardized Beta Coefficients	T	Sig.
(Constant)		-0.370	0.713
Age of maize marketer	0.092	1.478	0.144
Marital status	0.035	0.539	0.591
Educational level (years)	-0.001**	-0.022	0.002
Access to credit	0.026	0.497	0.621
Gender of maize marketer	-0.001	-0.018	0.986
Marketing experience	0.027**	0.419	0.006
Marketing Cost	0.883***	17.080	0.000
R Squared	0.824		
F-ratio	47.487		

Source: Computed from survey data, 2015
*sig 10%, **sig 5% and *** sig 1%

Table 3: Distribution of respondents according to challenges in maize marketing

Challenges	Frequency	Percent
Scarcity of maize/fluctuation/seasonality in supply	46	51.1
High cost of maize	37	41.1
Fluctuation in prices	34	37.8
Lack of central market	28	31.1
High taxes during transportation	22	24.4
Poor access road	20	22.2
Lack of finance/capital	19	21.1
High cost of labour involved in maize marketing	11	12.2
Poor access to information	7	7.8
Accident	5	5.6

Source: Field Survey, 2015 * Multiple responses

Profitability of Ornamental Plants Production in Southwest, Nigeria

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Abstract
Ornamental plants production is becoming increasingly popular as a business in Nigeria. Many people now venture into the business, and in the course of production some costs are generated and incomes are made. Based on this, the study was carried out to estimate costs and returns associated with ornamental plant production and identified the constraints facing the business. Snowball sampling technique was adopted in selecting one-hundred florists through the use of structured questionnaire. Descriptive statistics and budgetary analysis were used for data analysis. The result revealed that 73% of the florists were male with mean age of 44 years and mean experience of 13 years in the business. Budgetary analysis result showed that gross margin, net return and Rate of return on Investment (ROI) accrued to the florists were 180,594.46, 172,385.94 and 0.55 respectively, meaning that ornamental plant production was profitable in the study area. Although the business was profitable, it still faced some challenges among which are water scarcity, lack of permanent site for production and inadequate fund. Addressing the issue of water scarcity, lack of permanent site for production, inadequate fund, pest and diseases will further increase the income generated and profit made from the business.

*Keywords**:** Business, florists, budgetary analysis, cost*

INTRODUCTION

Horticulture is a branch of agriculture which deals with production, processing, storage and marketing of fruits, vegetables, spices and ornamental plants (Olaniyan, 2017). It plays an important role in the development of healthy living, promotes the outlook of community and enhances the economic and social values of the community (Abegunde *et al*, 2009). The cultivation and sales of horticultural crops provides markets for people. Ornamentals as part of horticultural plants are grown either for flowers or medicinal leaves, and, include a wide range of herbaceous annuals and perenials extensively employed in landscaping for aesthetic purposes of colour, fragrance and enhancing serenity in and around the home and public places (Shalnim, 2009). In recent years there has been increase in awareness of the benefits of planting ornamentals, and as a result ornamental business has increased across the country. In the course of production of the ornamental plants, some costs are generated while incomes are made also. It is therefore necessary to carry out empirical study on the profitability of ornamental plants production.

The findings of this research activity will further help to identify the challenges facing ornamental production business in south western Nigeria; and thereby proffer possible solutions. Finally, it will make the financial institutions to know whether ornamental business is a profitable venture and worth of giving loan facilities to its practitioners. The specific objectives of the study are to describe the socio-economic profile of the florists; to estimate costs and returns through ornamental plant production in the study area; and to identify the constraints to production of ornamental plants.

METHODOLOGY

Study Area: The study was carried out in southwest geo-political zone of Nigeria. The zone comprises of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti states

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with a total population of 27,581,922 and land mass of 76,652 (NPC, 2006). The zone is located on Latitude and Longitude 9.082 and 8.6753 respectively. The weather conditions vary between the two distinct seasons; the rainy season (March - November) and the dry season (November - February). It is majorly a Yoruba speaking area, although there are different dialects even within the zone. Added to these, the South Western population today is the most educated as western education in Nigeria.

Sampling technique and Data collection: Snowball sampling technique was adopted to locate ornamental plant producers in the study area. Primary data were collected through the use of structured questionnaire administered to one hundred respondents complemented with oral interview.

Data Analysis: Data were analyzed using descriptive statistics and budgetary techniques. Descriptive statistics (frequency, percentage and mean) were employed to describe socio-economic characteristics of the respondents and identify the constraints to production. Budgetary analysis (gross margin and net profit) was used to determine the profitability or otherwise of ornamental plant production in the region.

The gross margin is the difference between total revenue and total variable cost.

$$GM = TR - TVC$$

Net profit (π)**:** This is calculated by deducting fixed costs from gross margin.

$$\pi = GM - TFC)$$

Rate of Returns on Investment (ROI) is an indication of returns on every naira invested in a business and it is expressed as:

$$ROI = \frac{\pi}{TC}$$

Gross ratio (GR): It is a measure of solvency of the business. GR should be less than one. It is calculated by:

$$GR = \frac{TC}{TR}$$

Where, GM is gross margin ( ), TR is total revenue ( ), TVC is total variable cost ( ), TFC is total fixed cost ( ), π is net profit ( ).

The variable cost comprises of value of seedlings, cuttings, fertilizer, labour, polythene pots, pesticides, water among others while fixed cost comprises of land rent and depreciation on fixed inputs such as shovel, wheelbarrow, hoe, cutlass, secateurs, pruner and so on.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

Table 1 presents the socio-economic characteristics of ornamental plant producers in the study area. The result indicated that most of the respondents were male (73%) and married (84%), indicating that ornamental plant production is a male dominated activity and This might be due to the fact that the business of ornamental plant is labour intensive. The finding is in line with Adedutan (2015) who reported about 86% male engaged in ornamental nursery business in Akure metropolis, a part of Southwestern Nigeria. Most of the ornamental plant producers were within the age bracket of 31 and 50 years (59%) with the mean age of 44 years. This indicates that the respondents were mostly young adults and active. The result is almost similar to Akintoye *et al*, 2011 who stated that majority of florists were middle-aged. The respondents had tertiary education with average year of experience of 13 years in the business. This is an indication that the respondents were literate and have been long in the business. The combination of education and experience could make the producer to

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be efficient in managing the business which could lead to increase in productivity, resulting in increase in income (Ahmadu, 2017 and Ojo, 2002) .

Budgetary Analysis in ornamental plant production

In table 2, the estimate of cost and return shows that total variable cost was 307411.75 which represents 97.40% of total cost while total fixed was only 8208.52 (2.60%). The total revenue amounted to 488006.21. The gross margin and net profit of 180594.46 and 172385.94 were realized respectively. The Rate of return on investment was 0.55, indicating that for every naira invested in the business 55kobo is realized which more than 50% the amount invested. Gross ratio was less than 1 i.e 0.65 indicating that the business is solvent. All the indicators show that the business is profitable in the region.

Constraints to ornamental plant production and suggested solutions

Although the business was profitable, yet, it is still facing some challenges (Figure 1). The order of constraints as identified by the producers is as follows: Water scarcity > lack of permanent site for production> inadequate fund >low demand especially in dry season> pest and disease > labour scarcity > scarcity of planting materials> theft> lack of awareness. Water scarcity, inadequate land, insufficient fund, pests and diseases have been reported in the literature as problems facing floriculture business (Fakayode *et al*, 2011; Akintoye *et al*, 2011 and Adeduntan, 2015).

The respondents were asked to suggest possible solutions identified. Twenty-nine percent reported that in order ameliorate the problem of water scarcity they buy water and at times use water from drainage. The use of drainage water is not scientifically ideal as it contains heavy metal which will normally have adverse effect on plants. The respondents (24%) suggested that government should allocate land for ornamental plant production in their state. In order to solve the problem of low demand or sales, 19% suggested creation and promotion of awareness on the importance of ornamentals to environment and individual's healthy living. Government can provide loan to the florists in order to boost their business. 11% suggested use of pesticides to combat pest attack on their farm (Table 3).

CONCLUSION AND RECOMMENDATION

The study established that ornamental plant production was a profitable venture in the geo-political zone. In spite of this, ornamental plant business is still face with some constraints mainly: water scarcity, lack of permanent site for production and inadequate fund. Addressing these challenges will further increase the income generated from the business. Based on the findings, the study recommended that government should allocate land for ornamental plant production practice in form of "horticulture village". And this will also solve the problem of water scarcity during dry season because the florists will be able to sink well or borehole.

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Table 1: Socio-economic characteristics of respondents

Variable	Frequency	Percentage
Sex		
Male	73	73.00
Female	27	27.00
Marital status		
Single	16	16.00
Married	84	84.00
Age (years)		
<31	12	12.00
31-50	59	59.00
51-70	28	28.00
>70	1	1.00
Mean	44	
Educational level		
No formal education	2	2.00
Primary education	12	12.00
Secondary education	41	41.00
Tertiary education	45	45.00
Mean	13	
Years of experience		
1-10	48	48.00
11-20	34	34.00
21-30	16	16.00
31-40	2	2.00
Mean	13	

Source: Field survey, 2018.

Table 2: Result of budgetary Analysis in ornamental plant production

Item	Value ( )/month		Percentage
1. Total Revenue		**488006.21**	
2. Variable Cost			
Seed	8907.14		
Seedlings	55652.78		
Cuttings	18770.37		
Fertilizer	12894.87		
Labour	67340.34		
Polythene bag/pot	19201.30		
Herbicide (litres)	5219.44		
Pesticides (litres)	7163.01		
Water (litres)	28423.73		
Transporting	6915.79		
Advertisement	7666.67		
Fuel for pumping	16476.46		
Topsoil	24833.33		
Contingency	27946.52		
Total Variable Cost		**307411.75**	97.40
3. Fixed Cost			
Land rent	2875.41		
Depreciation on fixed assets	5333.11		
Total Fixed Cost		**8208.52**	2.60
4. Total Cost		**315620.27**	100
Gross Margin		180594.46	
Net Profit		172385.94	
GR		0.65	
ROI		0.55	

Source: Calculation from field survey data, 2018.

Table 3: Suggested solutions by the respondents

Solution	Frequency	Percentage
Purchase of water and use of water from drainage	29	29.00
Provision of land for ornamental plant production by state government	24	24.00
Creation and promotion of awareness	19	19.00
Provision of fund for florists	14	14.00
Use of pesticides	11	11.00
Provision of security against theft	3	3.00
Total	**100**	**100.00**

Source: Field survey, 2018.

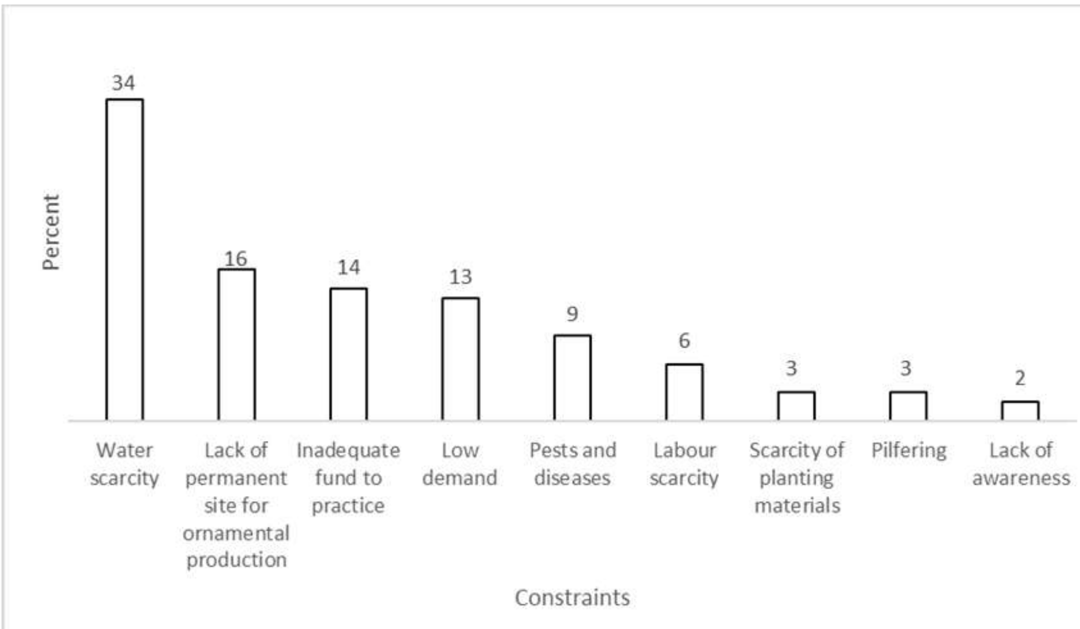

Figure 1: Constraints to ornamental plant production

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Preliminary Studies on Fruit Consumption among Primary and Secondary School Students in selected Schools of Oyo State

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Abstract
Fruit consumption has been linked to cognitive development of children, an essential component for knowledge acquisition. Based on the aforementioned, the study examined fruit consumption among primary and secondary school students. Purposive sampling technique was used to select 60 primary and 109 secondary school students. Data were collected using structured questionnaire and analyzed using descriptive statistics. Findings revealed that majority (52.6%) of the students in primary schools were males while 54.6% of the secondary school students were females. Most of the primary pupils were in the age group of 11-14 years (61.7%) while 69.4% of secondary school students were 15-18 years. Most preferred fruits by primary school pupils were banana (65.0%) and orange (63.3%); while apples (31.2%) and oranges (28.4%) were the most preferred by secondary school students. Consideration for the preferred fruits by primary school pupils was based on sweetness (89.8%), and health benefits (38.5%) by secondary students. Fruits eaten by secondary school students (50%) are purchased from hawkers while 28.3% of primary school students had urban market as their source of fruits. At school break-time, most of the pupils in primary school snacked on biscuit (55.2%) while secondary students' preference was for sweet (68.9%). Low percentage of primary (6.9%) and secondary (5.2%) school students consume fruits during the break period. Thus, the consumption of fruits among primary and secondary school students should be popularized and supported by government policy in the state, while a strong need also exists for educational enlightenment on the benefits of fruit consumption.
Keywords: fruit consumption, fruit preference, break period, students.

INTRODUCTION

Fruit and vegetable consumption is crucial to the availability of micronutrients to the body (Banwat *et al*, 2012). High intake of fruits and vegetables can prevent chronic diseases such as heart diseases and certain types of cancer (Key *et al*, 2002). An estimated 6.7 million deaths worldwide were attributed to inadequate fruit and vegetable consumption in 2010 (WHO, 2014). Reports have indicated that the intake of fruits and vegetables during childhood may reduce the risk of several childhood illnesses, including respiratory symptoms (Antova, *et al*., 2003).

In the period of adolescence, children require high nutrient requirement as they are rapidly growing; it is an important developmental life stage when dietary habits are established and may persist until adulthood (Verecken et al, 2015). Further, nutritional surveys consistently show that many children do not meet consumption levels identified in nutritional guidelines (Antova, *et al*., 2003). Cooke *et a*l (2003) provided further evidence of low consumption of fruits and vegetables in children, with more than one-third of children not consuming fruits and vegetables on a daily basis. In addition, the daily consumption per day of fruits and vegetables among children in many parts of the world, including sub-Saharan Africa, is below the minimum quantity recommended by the World Health Organization (WHO, 2003). Furthermore, several researchers found that children and adolescents are not eating the recommended five or more daily servings of fruit and vegetables (Curie *et al*, 2004).

Previous empirical research on fruit and vegetable consumption in Nigeria were those of Ilesanmi *et al*, (2014), Banwat *et al,* (2012). These studies focused on determinant of intake and consumption of fruits and vegetables among children in

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South west and North Central Nigeria. There is little empirical research on consumption of fruits specifically among children in Ibadan. There is therefore need for further research to identify effective interventions and policy approaches to improve the availability and accessibility of fruits in order to aid its consumption among school children. To accomplish this, continued efforts are needed to understand the level of children's fruit consumption in the study area.

METHODOLOGY

Study Area

The study was conducted in the Ibadan North West Local Government Area. Ibadan is the capital city of Oyo State and the third largest metropolitan area, by population, in Nigeria, after Lagos and Kano, with a population of over 3 million (Wikipedia, 2015 a). The city is located in South-western Nigeria, 128 km inland northeast of Lagos and 530 km southwest of Abuja, the federal capital, and a prominent transit point between the coastal region and the areas to the north. Ibadan had been the Center of administration of the old Western Region since the days of the British colonial rule, and parts of the city's ancient protective walls still stand to this day. The city ranges in elevation from 150 m in the valley area, to 275 m above sea level on the major north-south ridge which crosses the central part of the city. The city's total area is 3,080 square kilometres (1,190 sq m).

Ibadan has a tropical wet and dry climate with a lengthy wet season and relatively constant temperatures throughout the course of the year. The mean total rainfall for Ibadan is 1420.06 mm, falling in approximately 109 days. There are two peaks for rainfall, June and September. The mean maximum temperature is 26.46 C, minimum 21.42 C and the relative humidity is 74.55%.

The Ibadan North West Local Government Area has a population of about 152,834 from the National Population Census of 2006. It has eleven wards with its administrative headquarters at Onireke. It is bounded in the North by Ido Local Government, in the West by Ibadan South West Local Government, in the East by Ibadan North East and in the South by Ibadan South East Local Government. There are about 18 public primary schools and 11 public secondary schools in the local government (Oyo State Government, 2017).

There are numerous public and private primary and secondary schools located in the city. Presently the State has 2,004 public schools, 971 private nursery/primary schools, 969 public secondary schools including 7 schools of Science and 57 private secondary schools. Also in the State, there are five government technical colleges at Oyo, Ogbomoso, Ibadan, Saki and Igbo-Ora with enrolment of 2,829 students in the 2000/2001 academic session (Wikipedia, 2015b).

Sampling Procedure

Two primary and secondary school were purposively selected for the study. The schools are Saint Richard Primary Catholic Schools 1 and 2 while the secondary schools are Tobi International High School and Urban Day Secondary School. Semi structured questionnaire were administered to 60 and 109 randomly selected primary and secondary school students respectively.

Data analysis

Descriptive statistics such as frequencies and percentages were used to describe the socio-economic characteristics of respondents, frequency of consumption, most preferred fruit, reasons for preference, preference during break period, sources of purchase.

RESULTS AND DISCUSSION

Socio-economic characteristics of students

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The result in Table 1 showed that most of the sampled students in the primary school were males (52.6%) while females were more in the secondary school (54.6%). Most of the primary school (61.7%) pupils were in the 11-14 years age group while 69.4% of those in secondary school were aged 15-18 years. Moreover, 63.2% of primary school pupils are from households with 6-9 persons however, most (57.01%) of secondary school students live in households having 2-5 members.

Consumption Pattern of fruits by respondents

The four most consumed fruits by pupils in the primary school are oranges (98.3%), banana (98.3%), pawpaw (93.3%) and apple (88.3%). Similarly, secondary school students have orange (98.2%), plantain (92.7%), banana (92.7%) and apple (86.2%) as their most consumed fruits. This is contrary to the findings of Ilesanmi *et al* (2014) where most respondents consumed apple. This finding among primary school pupils is similar to that obtained by Layade and Adeoye (2012) which ranked banana as most-consumed fruit among the students in Ibadan, Oyo state unlike Mintah *et al*, (2012) which ranked banana in fourth position in the study carried out among students in Ghana.

Students' most preferred fruits

Primary school pupils stated banana (65.0%), orange (63.3%), and apple (58.3%) as their most preferred fruits while the secondary school students mostly preferred apple (31.2%), orange (28.4%) and banana (27.5%) (Table 3). Pear was the least preferred fruit by secondary school students (0.9%). This finding is contrary to that of Mintah et al, 2012 in their study on consumption of fruits by public University students in Ghana which reported that pear was the most preferred by students while orange was the least preferred.

Reasons for most preferred fruits by students

The result on Table 4 reveals that most of the pupils in primary school (89.8%) adduced preference for the fruits was because of it's sweet taste. The health benefits (38.5%) derived from the consumption of the most preferred fruit is the reason given by secondary school students. This is because they know the constituent of fruits as well as the health implication of consuming them probably because they have been taught in the class.

Fruit purchase for school students

Findings from Table 5 revealed that in the study area, mothers (55.0%) mostly buy fruits for primary school pupils while most of the secondary school students purchase fruits themselves (55.1%). This implies that what the primary school pupils consume is determined by their mother. The secondary school students are observed to have freedom of choice as they purchase what they want with the funds given to them by their parents.

Sources of Fruit Purchased

The result on Table 6 reveals that fruits consumed by the primary school pupils were purchased from the urban market (28.3%) but the secondary school students patronize fruit hawkers (50.0%) probably found in their school buttery. This finding supports the assertion that secondary students purchase fruits for themselves while mothers purchase it for the primary school pupils while shopping for household needs.

Students' preference during break period

Majority of the primary school pupils opined that they preferred biscuit (55.2%) followed by ice cream/yoghurt (13.8%) with their least preferred snack during break being fruits (6.9%) (Table 7). The secondary school students on their own prefer sweets (68.9%) followed by biscuit (15.5%) and fruit/ice cream (5.2%) during their school break period. The findings of

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this study is similar to that observed by Vijayalakshmi et al, 2016 which noted that 85% of the school children ate cookies, (cakes/wafers) as snacks while only 2% of them consumed fruits. This is also corroborated with the findings of Upton *et al* (2012) in which two-thirds of the children did not consume any fruit at lunchtime, and only 3% of children consumed at least one portion as part of their school meal across West Midland region in the United Kingdom.

CONCLUSION AND RECOMMENDATION

Findings revealed that most of the primary school students sampled were males (52.6%) and between 11-14 years of age (61.7%) while most (54.6%) of the secondary school students were female and aged between 15 and 18 years (69.4%). The four most consumed fruits by primary school students are orange, banana, pawpaw and apple. Secondary school students consume orange, plantain, banana and apple. Most preferred fruits by the primary school pupils were banana and orange however, secondary school students preferred apples and oranges. Primary school pupils' choice of fruit preference was because of its sweetness while the secondary school students have a little understanding of the health benefit of consuming the most preferred fruits. Most secondary school students purchase the fruits themselves from fruit hawkers while mothers purchased the fruits for primary pupils mostly from the urban markets. Despite the fact that secondary school students know that fruits are healthy, during school break-time, most of them prefer to buy sweet and other related snacks. Primary school pupils also prefer to buy biscuit during their break period with only few of them consuming fruits in the break period. Thus, policy should be enacted to ensure the consumption of fruits as part of their meal during the break period.

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Table 1: Socio-economic characteristics of students

Characteristics	Primary		Secondary	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Sex				
Male	30	52.6	49	45.0
Female	27	47.4	59	54.1
No response	3	5.0	1	0.9
Age (years)				
7-10	21	35.0	5	4.6
11-14	37	61.7	27	24.8
15-18	2	3.3	75	68.8
Above 18	-	-	1	0.9
No response	-	-	1	0.9
Household size				
2-5	17	28.3	61	56.0
6-9	36	60.0	45	41.3
>9	4	6.7	1	0.9
No response	3	5.0	2	1.8

Table 2: Consumption Pattern of fruits by students

Fruit	Primary		Secondary	
	Consumption Frequency (Percentage)	**Ranking of fruits consumed**	**Consumption Frequency (Percentage)**	**Ranking of fruits consumed**
Orange	59 (98.3)	1	107(98.2)	1
Plantain	52(86.7)	5	101(92.7)	2
Banana	59(98.3)	1	101(92.7)	2
Apple	53(88.3)	4	94(86.2)	4
Mango	51(85.0)	6	82(75.2)	6
Pear	22(36.7)	9	44(40.4)	8
Kiwi	3(5.0)	10	8(7.3)	10
Grape	27(45.0)	8	41(37.6)	9
Pawpaw	56(93.3)	3	86(78.9)	5
Pineapple	30(50.0)	7	66(60.6)	7

Multiple responses

Table 3: Students' most preferred fruits

Fruit	Primary		Secondary	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Apple	35	58.3	34	31.2
Banana	39	65.0	30	27.5
Grape	2	3.3	4	3.7
Mango	13	21.7	12	11.0
Orange	38	63.3	31	28.4
Pawpaw	2	3.3	14	12.8
Pear	-	-	1	0.9
Pineapple	5	8.3	7	6.4
Plantain	7	11.7	11	10.1

Multiple responses

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Table 4: Reasons for most preferred fruits by students

Reason	Primary		Secondary	
	Frequency	Percentage	Frequency	Percentage
Aids digestion	1	1.7	2	1.8
Delicious	1	1.7	-	
Gives energy/ It is healthy	23	38.9	42	38.5
Sweet	53	89.8	36	33.0
Like	1	1.7	10	9.2

Multiple responses

Table 5: Fruit purchase for school students

	Primary		Secondary	
Who buys	Frequency	Percentage	Frequency	Percentage
Daddy	24	40.0	24	26.9
Mummy	33	55.0	13	14.6
Myself	2	3.3	49	55.1
Others	-	-	3	3.4

Multiple responses

Table 6: Source of fruit purchase

Source	Primary		Secondary	
	Frequency	Percentage	Frequency	Percentage
Fruit hawkers	7	11.7	30	50.0
Neighbourhood market	3	5.0	9	8.3
Rural market	1	1.7	3	2.8
Urban market	17	28.3	2	1.8
Grocery	3	5.0	2	1.8
Supermarket	-		1	0.9
Other	-	-		2.1

Table 7: Preferred snack items by students during break period

Items preferred in break period	Primary	Secondary
	Percentage	Percentage
Sweet	6.9	68.9
Biscuit	55.2	15.5
Fruit	6.9	5.2
Ice cream / yoghurt	13.8	5.2
Bobo drink	3.4	1.7
Gala sausage roll	6.9	-
Popcorn	3.4	1.7
Other	3.4	1.7

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Budgetary Analysis of Tomato Production in Kano State, Nigeria

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Abstract
The study was carried out to estimate the costs and returns associated with tomato production as well as identify the challenges facing the business in Kano state, Nigeria. A multistage sampling technique was used in selecting 100 tomato farmers from the study area. Information were obtained from the sampled farmers through the use of a well structured questionnaire. Descriptive statistics and budgetary analysis were adopted for data analysis. The result revealed that 91.0% of the respondents were male, with mean age and tomato farming experience of 40 and 14 years, respectively. Budgetary analysis result showed that gross margin, net returns and returns on investment accrued to the farmers were 0.58, 203,225.29 and 1.35, respectively implying that tomato production was profitable in the study area. Although the business was profitable, it faced some challenges among which are Tuta absoluta (Tomato disease), storage facilities, inadequate fund, high costs of transportation and fertilizer. Addressing these challenges will further increase the income generated and profit made from the business.

Keywords: Tomato production, gross margin, returns on investment, Nigeria.

INTRODUCTION

Tomato (*Solanium lycopersicum* L) is a highly nutritious vegetable used in the preparation of many foods (Ebra *et al*, 2013). As an important source of minerals, vitamins and health acids, tomato is one of the most important vegetable crops of *Solanaceae* grown universally (Tran, 2014) for home consumption and income. According to Sanusi (2015), demand for tomato is currently estimated at 2.45 million metric tons per annum, while the output is 1.8 million metric tons. Nigeria has a comparative advantage in the agricultural sector, especially in tomato production and processing (Foraminifera, 2016). Given that the demand for tomato and its by-product far outweighs its supply, tomato processing is a viable business in Nigeria (Foraminifera, 2016). With a population of over 170 million people and estimated national population growth rate of 5.7 per cent per annum, an average economic growth rate of 3.5 per cent per annum in the past five years (USAID, 2015), Nigeria has a large market for both fresh and processed tomato products. In Nigeria, tomato grows well in the Northern part of the country such as Kano, Kaduna, Katsina, Jigawa, Zamfara, Bauchi, Sokoto and Taraba states with Kano state having a comparative advantage for production of tomato on commercial scale (Umar and Yaro, 2017). It is against this backdrop that this study was conducted to do a budgetary analysis of tomato production in Kano State. Specifically, the study described the socio-economic characteristics of tomato farmers, estimated the profitability of tomato production, and identified the constraints of tomato production in the study area.

METHODOLOGY

Study Area

The study was carried out in Kano State. The State is located in the Sudan Savanna agro-ecological zones of Nigeria with a total population of 9,401,288 (NPC, 2006), making it the most populous State in Nigeria. The state covers a total land area of 20,760 square kilometer, located within latitude 8º30 N and longitude 11º30 E. It shares boundary with Katsina state to the North-west, Jigawa state to the North-east,

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Bauchi state to the South-east and Kaduna state to the South-west. Kano state is also divided into Kano North and Kano South and the metropolitan area. There are forty-four Local Government Areas (LGAs) in the state. Kano has a long history of agricultural activities and it is the most irrigated State in Nigeria with more than 3 million hectares of cultivated land (Mustapha, *et al*, 2014).

Sampling technique and data collection

Multistage sampling technique was employed in the selection of tomato producers in the study area. The first stage involved the purposive selection of Kano North and Kano South LGAs; the two LGAs are known for tomato production in the state. The second stage involved the selection of two villages each from the selected LGAs. The final stage was the random selection of twenty-five tomato farmers in each of the four villages, resulting into a total of 100 respondents. The data for the study were collected with the aid of a well structured questionnaire and covered the 2015 cropping season.

Data analysis

Data were analyzed using descriptive statistics and budgetary techniques. Descriptive statistics (frequency, percentage and mean) were employed to describe the socio-economic characteristics of the respondents and assess the constraints of production. Budgetary analysis (gross margin and net profit) was used to determine the profitability or otherwise of tomato production in the study area.

The Gross Margin (GM) is the difference between total revenue and total variable cost.

$$GM = TR - TVC \quad \ldots\ldots\ldots\ldots\ldots (1)$$

Net profit (π)**:** This is calculated by deducting fixed costs from gross margin.

$$\pi = GM - TFC \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Rate of Returns on Investment (ROI) is an indication of returns on every naira invested in a business and it is expressed in percentage as:

$$ROI = \frac{\pi}{TC} X100 \quad \ldots\ldots\ldots\ldots\ldots\ldots(3)$$

Where, GM is the gross margin, TR is total revenue, TVC is total variable cost, TFC is total fixed cost and π is the net profit. The variable cost comprises of cost of inputs such as planting materials, fertilizers, labour, baskets, herbicides, pesticides, water among others, while fixed cost comprises of land rent and depreciation on fixed inputs.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Socio-economic characteristics of the respondents are displayed in Table 1. The results showed that 91.0% of the respondents were male, indicating that tomato cultivation is a male-dominating activity. This may be due to the fact that farming activities involves drudgery which is easily accommodated by males as stated by Oladeebo *et al* (2013). Mean age of the farmers was 40 years, but specifically, most (61.0%) of them were in the age range of 21-50 years, while 13.0% were above 50 years. This is an indication that farmers in the study area are young and in their economic active age. This is against the assertion that young people are not interested in farming practices (Youthinfarming, 2011). Also, 82.0% of the respondents were married with mean household size of 10 persons. This indicated that the respondents were responsible and had families to cater for. Large household size would encourage the respondents to make use of family labour in tomato production in the study area. In terms of educational level, most (32.0%) of the respondents had quranic education, 27.0% had secondary education, 22.0% possessed tertiary educational, while the

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least (18.0%) had primary education. This implied that respondents were literate and this would help them in understanding the technicalities involved in tomato production. Most (46.0%) of the respondents had between 10-19 years experience in tomato production, meaning that they are well experienced in the business. The combination of education and experience could make the producer to be efficient in managing the business which could lead to increased productivity and income (Ahmadu, 2017).

In Table 2, more than 50.0% had less than 1 hectare farm size, while only 5.0% had 6-15 hectares. On the average, respondents cultivate tomato on 1.5 hectares of land indicating that tomato farmers in the study area were small-scale farmers. Most (37.0%) of respondents acquired their farmland through inheritance, while 22.0% acquired it as gift. This has been pointed out as the bane of African agriculture because it will be difficult for the farmer to expand his business. More than average (55.0%) sourced their planting materials from open markets where the viability of the seeds is uncertain, 18.0% obtained seeds from private companies, only 2.0% obtained from research institutes. Tomato farmers were highly involved in social groups as 70.0% were members of farmers' association. Their participation in association was due to the benefits they derived from it such as sales of produce (33.0%), access to loan (11.0%), tractor (33.0%) and agrochemicals (11.0%).

In Table 3, the budgetary analysis of tomato production showed that total variable cost was 110,955.20 which represented 93.77% of total cost, while total fixed was only 39,458.01 (6.2%). The total revenue amounted to 353,638.50, while gross margin and net profit of 242,683.30 and 203,225.29 were realized, respectively. The Rate of return on investment was 1.35, indicating that for every naira invested in the business 1.35 net profit was realized. All the indicators showed that the business was profitable and viable in the study area.

The constraints to tomato production in the study area are displayed in Table 4. *Tuta absoluta* (Tomato disease) ranked first among constraints to tomato production in the study area. This was followed by lack of tomato storage facilities, inadequate fund, high costs of transportation and fertilizer. This corroborates the findings of Sodiya *et al.,* (2014) who reported that pests and diseases play an important role in agribusiness. Other constraints were bad road network, scarcity of improved seeds and price fixing by middlemen.

CONCLUSION AND RECOMMENDATIONS

The study established that tomato production was profitable in the study area. However, a number of problems faced the production of tomato. Prominent among the problem was *Tuta absoluta* (Tomato ebola) disease. It is therefore recommended that efforts should be geared towards addressing these challenges in order to make tomato production more profitable and viable.

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Table 1: Distribution of respondents by socio-demographic characteristics

Variable	Frequency	Percentage
Sex		
Male	91	91.0
Female	9	9.0
Total	100	100.0
Marital status		
Single	18	18.0
Married	82	82.0
Total	100	100.0
Age (years)		
<20	19	19.0
21-30	27	27.0
41-50	34	34.0
51-60	10	10.0
>60	3	3.0
Total	100	100.0
Average ≈ 40		
Educational level		
Quranic	32	32.0
Primary education	18	18.0
Secondary education	27	27.0
Tertiary education	22	22.0
Total	100	100.0
Household size		
1-10	43	43.0
11-20	19	19.0
21-30	9	9.0
No response	29	29.0
Total	100	100.0
Average ≈ 10		
Years of experience		
<10	31	31.0
10-19	46	47.0
20-29	16	16.0
30-39	5	5.0
>39	2	2.0
Total	100	100.0
Average ≈ 14		

Source: Field survey, 2015.

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Table 2: Distribution of respondents by socio-economic characteristics

Variable	Frequency	Percentage
Land size (ha)		
Less than 1	56	56.0
1-5	39	39.0
6-10	4	4.0
11-15	1	1.0
Total	100	100.0
Average ≈ 1.5		
Source of land		
Purchased	17	17.0
Inherited	37	37.0
Rented	29	29.0
Gift	22	22.0
No response	5	5.0
Total	100	100.0
Source of planting materials		
Open markets	55	55.0
Research institute	2	2.0
Private seed company	18	18.0
Friend's farms	20	20.0
Own farm	5	5.0
Total	100	100.0
Belong to farmer's association		
Yes	70	70.0
No	30	30.0
Total	100	100.0
Benefit derived from association		
Sales of produce	33	33.0
Access to loan	11	11.0
Tractor rentage	33	33.0
Agrochemicals	11	11.0
No response	12	12.0

Source: Field survey, 2015.

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Table 3: Budgetary analysis of tomato production

Item	Value ( )/month		Percentage
1. Total Revenue		**353,638.50**	
2. Variable Cost			
Planting material (Seed)	6,364.63		
Fertilizer	6,430.30		
Herbicide (litres)	2,323.33		
Pesticides (litres)	3,220.20		
Water (litres)	4,961.19		
Basket	16,635.45		
Labour:			
Land preparation	20,508.25		
Planting	9,288.14		
Fertilizer application	2,423.71		
Herbicide/pesticide application	3,218.95		
Watering	10,944.19		
Harvesting	14,550.00		
Contingency	10,086.83		
Total Variable Cost		**110,955.20**	93.77
3. Fixed Cost			
Land acquisition	36,131.31		
Depreciation on fixed inputs	3,326.70		
Total Fixed Cost		**39,458.01**	26.23
4. Total Cost		**150,413.21**	100.00
Gross Margin		242,683.30	
Net Profit		203,225.29	
ROI		1.35	

Source: Calculation from field survey data, 2017.

Table 4: Constraints to tomato production

List of possible problems	Not a problem	Severe problem	Very severe problem	Mean score	Mean rank
Tuta absoluta (Tomato ebola)	1 (1.00)	5 (5.00)	94 (94.00)	2.93	1st
Lack of tomato storage facilities	2 (2.00)	27 (27.00)	71 (71.00)	2.69	2nd
Inadequate funds	2 (2.00)	39 (39.00)	59 (59.00)	2.57	3rd
High transportation cost	-	58 (58.00)	42 (42.00)	2.42	4th
High cost of fertilizer	-	59 (59.00)	41 (41.00)	2.42	4th
Bad road	1 (1.00)	65 (65.00)	34 (34.00)	2.33	6th
Scarcity of improved seed	24 (24.00)	46 (46.00)	30 (30.00)	2.07	7th
Fixing of prices by middlemen	42 (42.00)	44 (44.00)	14 (14.00)	1.72	8th

Note: values in parenthesis are percentages

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Assessment of Growth Media for Vegetable Seed Germination Test for Aquaponic System

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Abstract
*Aquaculture has been a sustainable source of food security and poverty alleviation for Nigerian families but can be more profitable if upgraded to aquaponics systems. Aquaponics is relatively new in Nigeria although vegetable and fish consumption has been a regular part of Nigerian diets. Therefore, a study was carried out to assess the potentials of some growth media for vegetable - aquaponics culture system in Nigeria. Twenty seeds each from two selected vegetables (lettuce var. grace lakes and amaranth var. Bunchy) were grown on different media namely; Luffa cylindrical, tissue paper, cotton wool and soil which served as the control. These were laid out in a 4*2 factorial design on a flat germination tray. The experiment was repeated twice. The seed germination rate from each medium was compared to the control. Data were analyzed using descriptive and inferential statistics. Increase in length, shoots and roots of germinated seedlings were observed at 4, 10 and 14 days after sowing (DAS). Amaranthus + Luffa, Amaranthus + cotton wool, Amaranthus + tissue paper, lettuce + cotton wool recorded 100% germination; with a 90% germination in lettuce + Luffa, Lettuce + tissue paper, Amaranthus + soil, while Lettuce + soil gave the lowest germination rate of 80.7% at 10 DAS. Luffa cylindrical is an effective and efficient growth medium for vegetable - aquaponics system in Nigeria and it should be encouraged because of availability.*
*Keywords**:** Vegetable - aquaponics, Lettuce, Amaranthus, food security, farming system, horticulture.*

INTRODUCTION

Horticulture and fisheries can play vital roles in ameliorating food insecurity and nutrition situations. According to Oladimeji *et al*., (2018), horticultural crops production alongside fisheries can effectively combat global food and nutritional insecurity which is caused by population explosion and urban agglomeration(Consulting, 2013). In many countries, the current rates of expansion of urban agglomeration are accompanied by the challenges of food and nutrition security.

Aquaponics system is one of the most effective ways of conserving fish pound waste water as well as recycling fish wastes by growing vegetables.Urban areas are also confronted with the problem of inadequate land for agricultural activities but with the combination of vegetable production and fish enterprise, more food will be available for the urban population, that is why the right to adequate food is universal and good nutrition is essential for all(Silva*et al*., 2017). Good nutrition is the source of energy to live an active life. However, the problem of malnutrition such as under-nutrition, micro-nutrient deficiency and obesity exist in all countries and cut across socio-economic classes (Cattaneo *et al*., 2008) and emerging challenges of climate change, environmental sustainability, and rapid technological shift are transforming the food systems; giving rise to the question on how to feed the ever-growing population sustainably (Consulting, 2013), could be tackled if more farmers adopts aquaponics systems. Aquaponic is simply a system designed to combine Aquaculture and hydroponics. It can be utilized for horticultural crops production to enhance yield.This allows the nutrients produced by fish in a form of waste water be used by the plants which in turn help to purify the pound water making it suitable for fish production as it serves as a recycled concept, (Bruce *et al*., 2016). Yang and Kim (2016), reported that tomatoes, lettuce

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and basil are among the horticultural crops suitable for aquaponics system. Some of the advantages of aquaponics system include the use of soilless medium where small space needed to produce more outputs (Geisenhoff *et al*., 2016), all year round production and availability of organic fertilizer fromfish waste thus discouraging the use of agro-chemicals (Saha *et al*., 2016;Orsini *et al*., 2013).

Agriculture is one of the largest non-oil sectors with high potential to revive the Nigerian economy as it can serve as an aspect of urban agriculture,(Bryld, 2003). Aquaponics is a clear solution like the recommendation in Bangladesh for urban farming as reported by

Farmers in the urban centers sometime utilize polluted soil and water that are not healthy and environmentally friendly for fresh vegetable production, hence it will really serve as a major relief to urban farmers, (Alaimo*et al*., 2008). Aquaponics system posits an economically advantageous symbiotic Saha*et al.*, 2016) hence; vegetables can be raised alongside fish in the compound which is an advanced form of compound farming or home gardening in Urban Agriculture (UA). In Nigeria, aquaculture and horticulture are practiced singly within the UA system. Both can be integrated into aquaponics system with associated benefits of maximum resources utilization and conservation. Production of seedlings in appropriate media before transplanting into the permanent field is an integral part of horticultural production practice.

The technique of aquaponics-seedling production essence is to make transplanting easier and prevent injury or lesion during transplanting operation. Therefore, theobjective of this study was to assess different germination media for vegetable seedling production for aquaponics system.

MATERIALS AND METHODS

This study was carried out at the National Horticultural Research Institute Ibadan, Oyo state, Nigeria (Latitude $7^0$24'47.07" N and Longitude $3^0$51'27.906" E; 218.6masl). Soilless media used were locally available materials such as cotton wool, tissue paper and fibrous sponge (*Luffa cylindrical* (*L*) with soil as control. The fibrous sponge was cut into three (3) portions. The middle portion was immersed in a bowl of waterhalf of the fibrous sponge submerged while half portion of the material was above the water surface. As a result, the fibre allowed water to permeate from the portion in the water to the portion above the water, hence remained moistened. The cotton wool and tissue paper were folded length wise in a square shape with a thickness of five centimeter (5cm) each and moistened. Twenty seeds each of *Amaranthus* and Lettuce were sown on each of the media on the same day and kept under shade. The water level was maintained to avoid desiccation. The four (4) media and two (2) vegetable seeds were laid in a completely randomized design (CRD) in three (3) replicates in a 4*2 factorial arrangement. Data collected were number of days to germination and germination count at 4 and 10 Days after Planting (DAP). Data was subjected to analysis of variance and means were separated using LSD test at 5% probability level using statistical Analysis System (SAS 9.4 version).

RESULTS AND DISCUSSION

Rate of vegetable seeds germination as influenced by different media

The result in Table 1 shows the effect of different growth media on germination of *Amaranthus* and Lettuce, there was no significant difference between the number of seeds germinated at 4DAP and 10DAP in the four-growth media for both crops at ($p>0.05$) . However, the highest number of seeds germinated was recorded for seeds sown in growth media containing cotton

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wool, followed by tissue paper and *Luffa.* Growth media containing soil had the least mean value. Looking at the overall mean results, *Luffa,* cotton wool and tissue paper influenced 100% germination at 10DAP while soil gave the least germination using *Amaranthus* as the test crop seed. These results can be attributed to low aeration in soil medium than other media used. Lettuce had 100% mean germination value only on cotton wool growth medium while tissue paper and *Luffa* gave 90% mean germination. The top soil consistently gave the least (80.7%) mean germination count. However,*Luffa*occurs naturally, but has little or no economic value at present hence can be exploring as germination media.

Results of the interactions between the germination media and the test crop seeds is presented in Table 2. The interaction showed that, *Amaranthus* + *Luffa*, *Amaranthus*+ cotton wool, *Amaranthus* + tissue paper and lettuce + cotton wool had 100% germination. Lettuce + *Luffa*, Lettuce + tissue paper, *Amaranthus* + soil had 90% germination while Lettuce + soil gave the lowest germination (80.7%) at 10 DAP. All the soilless media supported germination of the test crops better than soil. Looking at this result from cost perspective; both tissue paper and cotton were purchased while *Luffa* was obtained at no cost because it is a volunteer crop growing in the wild without any appreciable economic value at the moment. The *Luffa*, therefore be considered a medium for aquaponics system for the cultivation of vegetables.

CONCLUSION AND RECOMMENDATION

All the tested soilless media supported higher germination of *Amaranthus* and lettuce than top soil. Cotton wool and tissue paper had financial cost implication while *Luffa* did not have. Therefore, local materials such as Luffa are recommended for aquaponics and hydroponics-basedseedlings production in the nursery.

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Table 1: Effect of nursery growth media on germination of vegetables

Treatment	4DAP	10DAP	Overall
Amaranthus			
Luffa	19.33	0.67	20.00
Cotton wool	20.00	0.00	20.00
Tissue paper	20.00	0.00	20.00
Soil	19.67	0.00	19.67
LSD (0.05)	1.22	1.09	0.54
Lettuce			
Luffa	16.33	2.67	19.00
Cotton wool	19.33	0.67	20.00
Tissue paper	18.33	1.33	19.67
Soil	14.33	4.33	18.67
LSD (0.05)	6.41	7.43	1.80

DAP =Days after Planting

Table 2: The interactions between the germination media and crop seeds

Treatment	4DAP	10DAP	Overall
Crop+growth media			
Amaranthus+Luffa	19.33	0.67	20.00
Lettuce+Luffa	16.33	2.67	19.00
Amaranthus+cotton wool	20.00	0.00	20.00
Lettuce+cotton wool	19.33	0.67	20.00
Amaranthus+tissue paper	20.00	0.00	20.00
Lettuce+tissue paper	18.33	1.33	19.67
Amaranthus+soil	19.67	0.00	19.67
Lettuce+soil	14.33	4.33	18.67
LSD (0.05)	4.24	4.88	1.22

DAP =Days After Planting

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Adaptation Strategies to Climate Change by Smallholder Farmers in Akinyele Local Government area of Oyo state, Nigeria

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Abstract

Climate change has become a reality in Nigeria and it is indeed eating deep into the productivity and the entire livelihood of the populace. The smallholder farmers are the most affected in Nigeria due to their low technological advantage and low adaptive capabilities. The study was conducted to investigate the adaptation strategies to climate change by smallholder farmers in Akinyele Local Government area of Oyo state, Nigeria. Sixty respondents were randomly selected; from three communities (Ajibode, Ajeja and Alabata) in the local government. Both qualitative (In-depth interview) and quantitative tools (structured interview schedule) were used for data collection. The result of the study was analysed using descriptive statistics. Out of 32 adaptation strategies presented to the respondents, they mainly use prayer, diversifying income through altering integration with other farming activities, different planting dates, and altering input such as varieties/species as one form of adaptation strategies with theses means0.72, 0, 62 and 0.61 respectively. We then conclude that more extension personnel should be made available to farmers for enlightenment on various adaptation strategies.

Key words: *Adaptation strategies, Climate change Awareness, Smallholder, Akinyele Displacement*

INTRODUCTION

The population involved in farming is 60-70% of which small-holder farmers constitute 80% of all farm holdings; their production system is inefficient, which leads to regular shortfall in national domestic production (FAO, 2005). About two-third of the crop area is in the North, with the rest being equally distributed between the middle belt and the Southern part of Nigeria (National Bureau of Statistics, 2005). Farm holdings generally fall into three categories namely; small-scale (0.1 to 5.99 ha), medium scale (6 to 9.99 ha) and large scale (10 ha and above). Small-scale farm holdings predominates Nigerian agriculture, accounting for 81% of the total area and 95% of agricultural output (Aliyu and Shaib's (1997). Climate change leads to change in rainfall patterns which consequently affect agriculture, food security and economic growth and causes increase in temperature, prevalence of vector-borne diseases, sea level and variability of floods and drought (DFID, 2004). It should be noted that climate change is not just an environmental, scientific or technological concern; it is also hinged on social issues with particular importance placed upon gender-specific realities. The causes and effects of climate change are multifaceted involving social, political and economic as well as environmental factors (Olawoye, 2010). Adaptation includes the actions of adjusting practices, processes and capital in regions to the actuality or threat of climate change as well as responses in decision environments such as changes in social and institutional structures or altered technical options that can affect the potential or capacity for these actions to be realized. (Howden et-al, 2007)). In bringing about resilience in agriculture to the effect of climate change in Nigeria: Extension worker will have to play the following roles: technologies and management information, capacity development and facilitating and implementing policies and programs (Mustapha *et al*, 2012).The above roles are very important since agricultural extension

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has been defined as a series of embedded communicative interventions which supposedly help to resolve problematic situations (Leeuwis, 2006), in which climate change can be accommodated.

Generally, inadequate extension service in terms of personnel for farmers to get information is a serious problem to agricultural development in Nigeria, not only in crop production but in accessibility to information about climate change as well. Farmers' adequate knowledge and information about climate change will give them ability to adapt at any point in time.

The general objective of the study is to determine the social effects of climate change among smallholder farmers in south western Nigeria. While the specific objectives are to:

i. identify the personal characteristics of smallholder farmers in the study area
ii. assess the respondents' awareness of changes in major climate parameters
iii. identify respondents' Perceived causes of climate change
iv. ascertain the adaptation strategies of smallholder farmers due to climate change and

METHODOLOGY

Akinyele Local Government Area is located in Moniya, comprising of the district and villages of Ikereku, Iroko, Moniya, Idi, Ori, Ileba, Salako, Togiri, Anisere, Asani, Ejitolu, Elewintan, Folarin, Idi-Odan, Mele, Molarere, Okegbemi, Ojerinde, Olode, Ajibode, Ajeja, Alabata etc. Akinyele is one of the Local Government Areas in Oyo state, Nigeria which was created out from Ibadan Municipal Government in 1976 during the regime of General Muritala-Obasanjo. This LGA hosts some of the notable higher institutions in the state such as Nigeria Institute of Social and Economic Research, International Institute of Tropical Agricultural, Federal School of Statistics, the proposed Dominican University, Second Mechanised division known as Odogbo Cantonment and some parts of University of Ibadan Land area also fall within the Local Government around Apete.

Sixty respondents were randomly selected; from three communities (Ajibode, Ajeja and Alabata) in the local government. Both qualitative (In-depth interview) and quantitative tools (structured interview schedule) were used for data collection. The result of the study was analysed using descriptive statistics (frequencies and percentages).

RESULTS AND DISCUSSION

Personal characteristics of respondents

Majority (72.2%) of the respondents were males while 27.8% were females (Table 1). This could be associated with the prominent roles men play in Agricultural production in the country. The issue of access to land claimed to be the reason why more males are involved farming than their female counterparts. It could also be the reason why gender differentiation exists in respect of the land ownership in most communities where women do not have ownership rights over land, although they may have rights to use. The study is in line with various past studies for example that of Adebisi-Adelani 2014. Also 94.4% of respondents were from Yoruba ethnic group, the reason for this may be as a result of the study area. Furthermore the Table reveals that 83.3% were married with 15.0% singles. This implies that almost all the smallholder farmers' interviewed were married. This could be attributed to family labour used for farm operations in Nigeria and majority of farmers practise polygamy and have many children so that they can help in farm operations. The amount of family labour available is usually closely related

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to the marital status of the farming household (Muhammad-Lawal, Omotesho and Falola, 2009). Also, 76.7% had a modal family size of 5-8 respectively. This depicts a fairly large family size in Nigeria. The implication of this finding is that if the family size is big, there will be more people available as family labour. This could be linked to the issue of marital status.

In the same vein, 61.1% are into integrated farming, implies that farmers in Nigeria combines various activities, they do not practice monoculture. While 55.6% of respondents remarked that extension agents are not visiting them, this could be attributed to the low farmers' extension ratio.

Respondents' awareness of changes in major climate parameters

The result of the study (Table 2) further revealed that majority (88.2 %,) of the respondents are quiet aware of the general decrease in yearly amount of rainfall. The respondents when interviewed personally affirmed this that there has been decrease in the amount of rainfall for the past five years. Moreover, 75.0% confirms intense harmattan, all respondents (100.0%) were of the opinion that there was reduction in rainfall days as the time when the data was collected. Most importantly 70.6% affirms increase possibility of loss of nutrients which they said might have been responsible for their low yield over the years. This implies that majority of farmers are aware of change in climate parameters as it affects their production. The findings were consistent with Oyekale *et al* (2009) who reported that 58.6% of cocoa farmers in Nigeria were aware that there is low rainfall in recent years among other climatic phenomena.

Respondents' Perceived causes of climate change

The result in Table 3 reveals that majority (82.4%) disagreed with the fact that emission from car road and transport causes climate change while 82.4% as well disagreed that carbon dioxide emission causes change in climate. Also 70.6% disagreed with the fact that emission from power station/ factories/industries causes climate change. Furthermore 76.5% did not believe that burning fossil fuel for energy can cause climate to change, so also 88.2% disagree that deforestation/ cutting down trees causes change in climate and 83.3% does not agreed to the fact that sea pollution causes climate change. On the other hand 65.5% agreed that they don't believe in climate change. This implies that though they are aware of climate change parameters but they don't believe in the causes and that is why so many people still engage in deforestation, they still pour dirt on streams which later resulted into flooding after blocking water ways. This is in line with other studies where farmers in Nigeria believe that climate change is an act of God and not manmade.

Respondents' use of adaptation strategies

The result (Table 4) reveals that most of them practice less adaptation strategies. Out of 32 adaptation strategies presented to the respondents the highest mean is 0.72 which is use of prayer. This implies that respondent mainly use prayers to combat the effect of climate change and this can be linked to their knowledge on the causes of climate change. Thus the result is in line with past literatures which reveal that respondents acclaim everything about climate change to God. Also the next mean value is 0.62 which is diversifying income through altering integration with other farming activities and barriers hedges along contours to the soil erosion. This implies that farmers ventures into other income generating activities so as to be able to meet up with their responsibilities. The study is in consonance with several studies on climate change. The next mean value is 0.61 which

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is different planting dates and altering input such as varieties/species as one form of adaptation. Lesser mean of respondents use other adaptation strategies as further revealed in the Table. This is an indication that horticultural farmers in south western states practised less adaptation strategies when compared with their counterparts in the North.

CONCLUSION AND RECOMMENDATION

The study concluded that the respondents are quiet aware of changes in major climate parameters, though they have this awareness but they did not agree to major causes of climate change. Thus their not having the knowledge of the causes may be a major factor to their less use of several adaptation strategies as revealed in the study. From the study also we found out that extension agents are not conversant with them any longer. We then recommend that more extension personnel should be made available to farmers for enlightenment in the area of adaptation strategies and exposure to causes of climate change.

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that adaptation strategies to climate change are not well practised among smallholder farmers in South western Nigeria. It is in line with former study carried out by Adebisi-Adelani (2011) which revealed

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Table 1: Distribution of respondents based on personal characteristics

Variables	Frequency	Percentage
Sex		
Male	43	72.2
Female	17	27.8
Ethnic background		
Yoruba	56	94.4
Igbo	-	-
Hausa	4	5.6
Others(Specify)		
Marital Status		
Single	9	15.0
Married	50	83.3
Divorced	-	-
Widowed	1	1.7
Family size		
1-4	5	8.3
5-8	46	76.7
9-12	7	11.6
13-16	2	3.3
Practices integrated farming		
Yes	37	61.1
No	23	38.9
Extension agents' visit		
they used to but not anymore	33	55.61
they do sometimes (specify how often)	12	20.40
no not at all	15	23.99

Source: Field survey, 2017

Table 2: Percentage distribution of awareness of climate change parameters by respondents

Parameters	Yes (%)	No (%)
General decrease in yearly amounts of rainfall	88.2	11.8
Intense Harmattan period	75.0	25.0
Reduction in rainfall days	100.0	0.0
Increased possibility of loss of soil nutrients	70.6	29.4
Prolonged dry season	82.4	17.6
Incidence of sand dunes	15.0	85.0
wind dryness	70.6	29.4
Increased rainfall intensity	25.0	75.0
High Humidity	25.0	75.0
increased frequency of drought in recent decades	75.0	25.0
Sea level change, and Storm impacts	70.6	29.4

Source: Field survey, 2017

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Table 3: Perceived causes of climate change by respondents

S/N	Statement	Agreed	Disagreed
1	Emission from car road and transport	17.6	82.4
2	Carbon dioxide emission	17.6	82.4
3	Emission from power stations/factories/industries	29.4	70.6
4	Burning fossil fuel for energy	23.5	76.5
5	Deforestation/cutting down of trees	11.8	88.2
6	Hole in the ozone layer	11.8	88.2
7	Nothing, it is a natural process	70.0	30.0
8	I don't believe in climate change	65.5	34.5
9.	Sea pollution	16.7	83.3

Source: Field survey, 2017

Table 4: Frequency of use of Adaptation strategies

Adaptation strategies	Mean	Ranking
Crop management		
Altering inputs such as varieties/ species.	0.61	4th
Monitoring or improving quarantine capabilities.	0.32	25th
Use of varieties and species resistant to pest and diseases.	0.47	12th
Altering the timing or location of cropping activities.	0.58	6th
Different planting dates.	0.61	4th
Shorten length of growing period.	0.43	17th
Crop relocation	0.43	17th
Planting drought resistant varieties	0.42	19th
Soil fertility management		
Barriers hedges along contours to the soil erosion.	0.62	2nd
Change amount of land.	0.35	22nd
Soil protection through tree planting	0.53	9th
Soil conservation	0.47	12th
Water management		
Expansion of rainwater harvesting	0.33	24th
Water storage and conservation Technique	0.31	26th
Water re-use	0.21	27th
Desalination.	0.18	29th
Wider use of technologies to harvest water, conserve soil moisture.	0.48	11th
Managing water to prevent water logging, erosion and run-off.	0.57	7th
Increase irrigation.	0.40	20th
Planting flood resistant varieties	0.37	21st
Increase water conservation	0.45	15th
Pest and Insect management		
Planting pest and diseases resistant varieties	0.45	15th
Wider use of integrated pest and pathogen management, development.	0.46	14th
Diversification		
Move to different site.	0.55	8th
Changes from crops to livestock.	0.34	23rd
Farming to non-farming.	0.32	25th
Diversifying income through altering integration with other farming activities.	0.62	2nd
Others		
Prayer	0.72	1st
Change use of chemicals, fertilizers and pesticides.	0.49	10th
Use of weather insurance		27th

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Awareness of the Effects of Climate Change and Use of Amelioration Techniques among Rural Farmers in Akinyele Local Government Area of Oyo State, Nigeria

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Abstract
This study investigated farmers' awareness of the effect of climate change and the use of amelioration techniques in Akinyele Local Government, Oyo State. Multistage sampling technique was employed to sample 150 farmers who were served with a well- structured questionnaire, out of these 117 were retrieved. Data collected were analysed using descriptive statistical tools such as frequency counts and percentage, while Chi-square was used to test the hypotheses. The results show that the largest percentage (84.6%)of respondents was male.Greater proportions (44.4%) of them were between the ages bracket of 31-40 years and 62.4% were married. Majority (53.8%)of the respondents had primary education and most (97.4%) of themwere aware of climate change.The results also showed that themost common effect of climate change in the area was low yield (52.1%) response. The respondents got their information from the radio (63.2%). There was significant relationship (p<0.005) between gender, age distribution, marital status educational level and level of use of amelioration techniques*with p-value 56.077, 59.581, 9.308, 61.077, 36.974, 105.308 and 147.915 respectively. The findings indicated that the farmers were well aware of climate change and its likely effects on their agricultural production. It is recommended that government should intensify effort on creatingmore awareness and organize programmes on climate change to strengthen climate change adaption especially in rural areas.*
Keywords: Climate change, farmers, awareness, amelioration

INTRODUCTION

Climate change is a change in the statistical distribution of weather patterns when that change lasts for an extended period of time (decades to millions of years). Climate change may refer to a change in average condition, or in the time variation of weather around longer-term average condition (i.e., more of fewer extreme weather events). Climate change is caused by factors such as biotic process, variations in solar radiation received by earth, plate tectonics, and volcanic eruptions. Certain human activities have also been identified as significant causes of recent climate change, often referred to as global warming (Wikipedia, 2016).

Climate change is one of the most serious environmental threats to human beings as it adversely affects agricultural productivity (Zlervogel, 2006). The impact of climate change is global but the impact is mainly felt by the developing countries most especially Africa due to their low level of coping capabilities (Nwafor, 2007 and Jagtap, 2007). As the planet warms, rainfall pattern shift, and 4extreme events such as droughts, floods and forest fires become more frequent (Zoellick, 2009). Jones and Thornton, (2002) projected that crop yield in Africa may fall by 10-20% by 23050 or even up to 50% due to climate change because African agriculture is predominantly rain-fed and hence depend solely on weather.

The elements of climatic change that affect agricultural productivity include prolonged drought, thunderstorms, flooding of crop fields, erosion of fertile soil, landslides and falling of tender crops by wind (Magadza, 2000). International Panel on Climate Change (IPCC, 2007) reported that there have been noticeable impacts of climate change on plant production, insect, disease and weed dynamics. Climate change generally refers to changes in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the distribution of weather events around an average (Bello, 2010). Okoruwa (2010) referred to climate change as identifiable variability in climate that has brought about negative consequences to human survival.

Further, the awareness of climate problems and the potential benefits of taking action is important determinant of adoption of agricultural technologies (Hassan and Nhemachena, 2002). Nigeria and all the developing countries are already experiencing low crop yields as a result of extreme weather and climate change. These impacts are affecting ecological zones, causing shifts in their boundaries, altering animal and plant composition, increasing soil erosion and flooding activities in many areas due to higher rainfall, accelerating sea level rise and salt water intrusion along the coastal areas. Climate specialist has reportedly pointed out that a solution to climate change problem will require climate change awareness and its proper understanding.

In order to fast-track the awareness toward climate change, it is necessary to know people's level of awareness, adaptation measures are designed to assist the vulnerable to cope with and reduce the effects of the negative impacts while mitigation actions are designed to reduce the severity or/and prevent the global warming phenomenon adaptation and mitigation to climate change required local knowledge, local competence and local capacity and within local government (Ayodele and Akintola, 1990).

Crop farmers in Africa are acknowledged to have been very highly adaptable to climate change in both short and long terms while at the same time have the ability to develop effective means of handling variability in weather climate. Farmers' main adaptation strategies include use of drought tolerant crop varieties. A conventional case of this is switching from drought susceptible maize varieties to tolerant ones by Nigerian farmers. Other indigenous strategies that have emerged are changing planting dates, increased irrigation intensity and expansion in FADAMA farming, changing land use and management (Ayodele and Akintola, 1990).

Essentially, climate change is perhaps the most serious environmental threat facing the world. As the planet warms, rainfall patterns shift and extreme events as droughts, floods, river flow, surface albedo and intensification of land degradation. All these change have already affected human health, agriculture, available arable lands and forest resource, jeopardizing sustainable development and life of population (Bello, 2010). Climate change is the major and perhaps the most critical of all environmental challenges which confronts societies in the present century. Crucial information pertaining to perception of climate variability/change by people especially in the rural areas is still lacking. Successful implementation of mitigation and or adaptation strategies of any kind has strong bearing on the change in behavior of the people whose individual choices may have huge collective impacts at global scale. Adapting to climate change will require that individuals change their practices, which, in turn, are likely to require changes in the rules under which agriculture industry operates, the lack of enforcement of such rules, and the lack of participatory and accountability decision-making mechanisms are likely to increase socioeconomic vulnerabilities and limit the adaptive capacity of communities and societies Okoruwa (2010). It is against this backdrop that the study sought to determine the farmers' awareness ofthe effect of climate change and use of amelioration techniques among rural farmers in Akinyele Local Government of Oyo State.

MATERIALS AND METHODS

Akinyele is a local government area in Oyo state, Nigeria. It is one of the eleven local government areas that make up Ibadan metropolis. It headquarters are at

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Moniya. Akinyele Local Government was created in 1976 and shares boundaries with Afijio Local Government to the North Lagelu Local Government area to the east, Ido Local Government area lies between latitude 7^{o} 29' to 7^{o} 40 while its longitude ranges from 3^{o} 45' to 4^{o} 04. It occupies a land area of 464,892 square km using 3.2 percent growth rate from 2006 census figures, the 2010 estimated population for the local government is 239,745.The study area experiences a tropical type of climate. Akinyele Local Government recorded a mean annual temperature of about 32^{o}C. The relative humidity can be as high as 95% and a total of about 1250mm as mean annual rainfall. The target populations for this study were crop and animal farmers who chose farming activities as their primary occupations. The questionnaires were mainly distributed to the rural farmers. A multistage sampling procedure was used. First, 3 wards were randomly selected from the 12 wards while (stage two) 5 villages were randomly selected from each of the selected wards making 15 villages in total. In stage three, 10 farmers were randomly selected from each of the 15 villages giving a total of 150 respondents.They were interviewed through the use of a structured questionnaire. A total of 150 copies of questionnaires were administered and 117 copies were retrieved. All data collected were analyzed using descriptive statistics such as frequency, percentage, and chi-square.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents: Table 1: Shows the socio-economic characteristics of the respondents. Out of total of 117 respondents, 84.6% of the respondents were male while 15.3% of were female. This is in conformation of the positions that the male respondents primarily constituted the major farm labour in Nigeria (Nicholls,2004). Also, it is line with Nicholls (2004) who observed that the major agricultural production activities remains labour intensive due to poor level of mechanization and women could hardly combine their other non-farm activities with farming. A greater proportion (44.44%).of the respondents were between ages of 31-40 yearsIt is generally believed that this is an active age bracket and they should be more enlightened in accordance with the assertion of McGranahan, *et al*., (2007) who found out the people in this age bracket are the most innovative group. Most (62.40%) of the respondents were married people.. According to Akinbile (2007), marriage confers responsibility. The education level of respondents is majorly primary education (53.8%). This is reasonable but once there is an higher educational level, it leads to quick access and adoption of new innovation and its would change the economy while the secondary education (37.6%) and tertiary is (8.5%). Low level of educational attainment would limit respondents' access of information which might be of great assistance to them especially in the adoption of new farming activities (Adams, 2002).

Level of awareness of climate change by the respondents

Table 2 shows the level of awareness of climate change by the respondents. Awareness to this end is ensuring response to climate change the nature of awareness was to ask farmers if they have heard above climate change. The results show that majorities (97.4%) of the respondents were aware,that is they have heard about climate change while (2.5%) said they have not heard about climate change.The study showed the responses on climate (52.1%) refer to climate as average weather condition of a place, (37.6%) said climate change is the change in the atmosphere, while (10.2%) of respondent referred to climate as the change in the rainfall pattern. (Kunikulasuriya and

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Mendelsohn 2006) define climate change as the long term changes in average weather condition.

The table also shows how the problem of climate change can minimized (37.6%) optioned that stopping of bush burning will help minimized climate change. (36.7%) said that to minimized climate change there should be more teaching about how to minimize climate change. (17.0%) said stopping of deforestation will help minimize the problem of climate change, 8.5% said alternative energy source should be used in minimizing climate change.

The table shows that (40.1%) of the respondent agreed that problem of change is affecting them leading to change in the environment (26.4%) agreed that the problem affected them by reducing the amount of rainfall. However, how farmer feel the impact differs (17.9%) of the farmer planned of ill health (12.8%) of the respondent felt that climate change has cause pollution of the environment. Some farmers complain of excess heating (6.8%) while (4.2%) complained that climate change has leads to hotness of the body.

Solution to climate change effect on agricultural production

Table 3 shows the question of whether the problems of climate change affect rural farmers and how such effects can be overcome. The respondents overwhelmingly (84.6%) said yes. Most governments in Nigeria already have agencies charged with environmental issues including climate change and they most often sensitive the people through the radio and television.

This may explain the high level of awareness of the respondents. However (5.9%) of the respondents did not agree to weather the problem of climate change affect them. While (9.4%) gave no responses to weather the problem of climate change affect them. This underscores the need for educating the farmers however (F.A.O 2007) report that although climate change affect agriculture and vice versa, a lot of uncertainty pervades each of the logic from economic activity to climate change.Similarly, on the question of whether the problem of climate change affect them (rural farmers), 84.6% said yes and gave reason if picking yes 52.1% said low yield productivity 37.6% respondent to low income while 10.2% said its low rainfall. (Khanol, 2009) also noted that heat stress might affect the whole physiological development maturation and finally reduce the yield if cultivated crop. The observed effects of climate change on farmer's agricultural product by respondents include poor crop yield/production; delay planting date stunned growth, animal response is low. (75.2%) responded to poor crop yield, stunned growth of crops (13.6%), delay planting date (8.5) while animal response is very low (2.5%) leading to in sufficient food supply. Climate change is a threat to agriculture and food security because of the loss in food production through crop failure and increase in disease and mortality rate of livestock (Apodiaga and Odjugo. 2010).

The respondents in table 3 felt that to overcome climate change farmer (40.1%) needs to be prayerful, some suggested enlightens campaign (29.9%), 17.0% are prepared to face it while 12.8% of the opinion to stopping air pollution.

Awareness of amelioration strategies

Table 4 presents some of the strategies identified by the respondents in ameliorating the effects of climate change on agricultural production.

The statistics shows that the rural farmers are aware of the amelioration strategies put in place. A total of (84.6%) respondentsaffirmed in positivity that they are aware of the strategies put in place in ameliorating the effect of climate change while (15.3%) were not aware of the

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strategies put in place in amelioration effect of climate change.

Types of amelioration strategies

Table 5 presents different types of strategies in ameliorating long term climate change effects on agricultural production.

According to the statistics as shown in Table 5 many of the respondentswere of the opinion that switching to low carbon energy source (29.9%) is the solution, 29.0% explained that expanding forest by planting of trees will remove greater amount of carbon from the atmosphere.Further, 14.5% suggested that stopping deforestation and bush burning by some farmers(the most easy and common method of land preparation) would ameliorate the climate change effects.This practice thus requires much awareness in the area (Levin, Ludi, and Jones, 2011). Likewise, some respondents also suggested enlightenment by government (12.8%)while 13.6% ofthe respondents said that they are not sure if any of the amelioration strategies could solve the effect of climate change on agricultural production.

Relationship between socio-economic characteristic of the respondents and awareness about climate change.

Table 6 presents relationship between socio-economic characteristic of the respondents and awareness about climate change usingchi-square analysis. The results therefore revealedthat there is significant relationship between social-economic characteristic of the respondent and their level of awareness about climate change.

X^2-Value: Chi-Square value NS-Not Significant [p>0.005] S-Significant [p<0.005]

This implies that climate change is affected by the Gender (X^2=56.077, p<0.005), Age(X^2=59.581, p<0.005), Religion(X^2=9.308, p<0.005), Marital Status(X^2=61.077, p<0.005), Educational(X^2=36.974, p<0.005). This implies that farmers are aware of climate change and it's affected by socio-economic characteristic.

CONCLUSION AND RECOMMENDATIONS

From the findings, the conclusion drawn is that rural farmers to a large extent are aware of climate change, they are aware of climate change impact and have coping strategies. From the study, the analysis has revealed that rural farmers still request for more enlightenment about climate change and how it can be minimized since climate change is an environmental, social and economic challenge on a global scale. Virtually all the respondents were not only aware of climate change but also aware that some of its variables like change in the weather condition/rainfall pattern and uncertainties in the onset of framing season have been on the increase. In addition, they were also aware of the effect of climate change on their agricultural production by delaying planting date, low yield/production; stunned growth and animal's response are low. Some of the amelioration strategies by framer are to stop bush burning, deforestation, and expansion of the forest. Some of the variables/coping strategies adopted by the farmers in preparation for climate change include crop rotation, mixed farming, mulching, intercropping, planting of early maturing crops, quality seeds, and selective keeping of livestock in area where the rainfall decline. The major factor identified to be driving farmers awareness of climate change is to educate them more about climate change and how climate change can be minimized. The study reveals those rural farmers are aware of climate change and its likely effect. It also reveals the adaptation measure to cope with and reduce the effect of climate change while amelioration is designed to reduce the severity or/and prevent the global warming. Awareness on the issues

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of climate change still needs to be created by all necessary agents to increase the level of awareness of farmers. Also Government should organize programme on climate change to strengthen climate change adaption especially in rural areas.

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Table 1: Socio-economic distribution of the respondents

Variable	Frequency	Percentage
Sex		
Male	99	84.62
Female	18	15.38
AGE (Years)		
21-30	11	9.40
31-40	52	44.44
41-50	48	41.03
51-60	6	5.13
MARITAL STATUS		
Single	40	34.20
Married	73	62.40
Divorced	4	3.40
EDUCATION		
Primary	63	53.85
Secondary	44	37.60
Tertiary	10	8.55

Source: Field survey, 2016.

Table 2: Rural farmers' awareness on climate change

Variable	Frequency	Percentage
Have you ever heard about climate change?		
Yes	114	97.44
No	3	2.56
TOTAL	117	100
What is climate change?		
Distribution of weather patterns change	61	52.14
Change in the atmosphere	44	37.61
Change in the rainfall pattern	12	10.25
TOTAL	117	100
How can the problem of climate change be minimized?		
Stop bush burning	44	37.60
Teaching on climate change minimization	43	36.75
Stop deforestation	20	17.01
Alternative energy source	10	8.54
TOTAL	117	100
How does the problem of affect you?		
Lead to hotness of the body	4	3.14
Cause ill health	7	5.90
Leads to change of environment	47	40.17
Excessive heating	4	4.20
It reduces the amount of rainfall	39	33.30
It affect human skin	0	0
It causes pollution of the environment	15	12.82
TOTAL	117	100

Source: Field survey, 2016.

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Table 3: Solution to climate change effect on agricultural production

VARIABLE	FREQUENCY	PERCENTAGE
Do you think the problem of affect		
you	99	84.62
Yes	7	5.98
No	11	9.40
No response		
TOTAL	117	100
If yes how?	64	54.70
Low yield/productivity	37	31.62
Low income	16	13.68
No rainfall		
TOTAL	117	100
What is the effect of climate change		75.21
on your agricultural production?		8.54
Low yield	88	13.60
Delay planting date	10	2.55
Stunted growth	16	
Animal response is low	3	
TOTAL	117	
How do you think an individual can		100
help overcome the problem of climate		
change?	47	40.20
By prayer	35	29.91
Enlightenment campaign	20	17.09
Be prepared to face it	15	12.80
Stop air pollution	0	0.00
Make sacrifice to the gods	117	100
TOTAL		

Source: Field survey, 2016.

Table 4: Awareness of amelioration strategies

Amelioration strategies	Frequency	Percentage
Yes	99	84.62
No	18	15.38
TOTAL	117	100

Source: Field survey, 2016.

Table 5: Strategies in ameliorating long term climate change effects

VARIABLES	FREQUENCY	PERCENTAGE
Switching to low carbon energy source	35	29.91
Expanding forest to remove greater amount of carbon from the atmosphere.	34	29.05
Enlightenment by government	15	12.82
Stop deforestation/bush burning	17	14.52
Not sure there are any strategies	16	14.69
TOTAL	117	100

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Source: Field survey, 2016.

Table 6: Relationship between socio-economic characteristic of the respondents and awareness about climate change

VARIABLES	X^2	P-VALUE	DECISION
Gender	56.0077	0.0000	S
Age	59.581	0.0000	S
Marital Status	9.308	0.0002	S
Religion	61.077	0.0000	S
Education	36.974	0.0000	S

Source: Field survey, 2016.

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Assessment of Dry Season Urban Olericulture farming in the moist savannah transition zone of Nigeria

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Abstract
Olericulture plays a key role in the food and nutritional securities of sub Saharan Africa countries, especially in the off season. Our diagnostic studies assess therefore the dry season irrigation farming to better understand the characteristic problems and needs. This study was undertaken using an approximately designed interview schedule and the participatory learning approach methodologies. Data were collected by face-to-face interviews, personal questionnaire and assessment of the farms studied. A total of 113 farmers were interviewed. Results indicate that food/nutritional security cum climate change resilience could be attained by the farmers through provisions of adequate startup capital, irrigation wells, irrigation pumps, hose as well as drip/trickle irrigation kits to farmers to convey irrigation from source to farm site. The majority of farmers need basic agriculture extension training knowledge of crop-water requirement, irrigation scheduling and skills in maintaining and operating irrigation systems. These recommendations would clearly enhance farmers' use of rainwater for food security and climate resilience
Keywords: *Urban, Irrigation, Off-season, Olericulture, Capita, food security, climate*

INTRODUCTION

Urban and peri-urban agriculture is growing fast around all major cities in Africa with the increase of urban population and consequent rising demand for fruits and vegetables. Irrigated agriculture will need to expand rapidly in the future in order to cope with this rising demands. However, water resources are limited and irrigation is very labour demanding because in many urban and peri-urban farming, irrigation water is carried by hand from the well, reservoir or river to the field (Van Leeuwen, 2001).

Irrigation schemes in developing countries especially in sub-Sahara Africa (SSA) suffer from very low water use efficiency, resulting in water logging and salinity problems. Most readily available water resources have been mobilized already and a large part of the expansion of the irrigated area should come from the development of small-holder farmers of small local water resources such as small reservoirs and shallow groundwater. The optimal use of these limited resources is essential. The adoption of small-scale low-cost irrigation technologies by small-holder farmers in Africa has great potential and could be one of the solutions for increasing food production, increasing farmers' incomes and improving food security (Van Leeuwen, 2001; Hillel, 2001).

Vegetable production is done mainly during the rainy (major cropping) season in Southwestern Nigeria. During this season, vegetables are easy to grow as water is available and farmers can avoid the cost of irrigation (Olasantan, 1996; AVRDC, 1993). Vegetable production is one of the most important enterprises of peri-urban production systems in Nigeria because vegetables are an important component of human diet and they can be easily cultivated on small areas. Whereas, the Food and Agricultural Organization of the United Nations (FAO) and the World

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Health Organization (WHO) recommended a daily vegetable intake of 200g per person, the Nigerian National Average is below this values (Kintomo *et al*., 1997). This inadequate intake of fresh vegetables may further be worsened during the dry season when moisture scarcity limits the area under cultivation and quantity of vegetables that can be grown and supplied to the urban areas.

On the other hand, a previous study by Kintomo *et al*. 1997 in Ibadan indicated that it was more profitable to grow vegetables during the dry season when water is made available. Growing vegetables during this period also lead to higher quality products because of low disease pressures compared to vegetables grown under rain fed conditions. In that study however, 81% of farmers rated water management and/or poor drainage system as the most important abiotic constraint limiting dry season vegetable production. Ogunjimi and Adekolu (2002) harmonize authors and date with that in the reference advised that the problem of small-scale irrigation systems especially for vegetable production in Nigeria needs to be further studied. Hence, the objective of this work was to assess the irrigation systems within the urban and peri-urban vegetable production systems in order to proffer technological innovations that will enhance the productivity of the systems especially in the time of urgent needs.

Materials and Methods

The study was conducted from January to March 2010 within and around Lagos and Ibadan Cities. Lagos/Ibadan/Abeokuta is located in the humid forest/moist savannah transition zone (average 210 meter above sea level, 7^O 30'N, 3^0 54'E). Annual rainfall pattern is bimodal, with about 120-128 rainy days totaling approximately 1200-1400mm per annum. Rains usually begin in April and ends in November, with a mid-season dry spell in July and August. November to April is the dry season. Mean annual maximum and minimum temperatures range between 24 – 29^0C, 27 - 34^0C, and 20 - 30^0C for summer, autumn and winter. Mean relative humidity is 64 – 83%.

The locations studied spread across urban and peri-urban areas of Ibadan and Lagos, Southwestern Nigeria and included Molete-Bode, Lade-Ido-Abeokuta, Abanla, Ijanikin-Lagos, and Akufo farm settlements. The study was undertaken using an approximately designed interview schedule and the participatory learning approach. Data were collected by face-to-face interview and personal questionnaire/assessment of the farms. A total of 113 farmers were interviewed. Some of the issues addressed by the questionnaire include socio-economic parameters, source of irrigation water, irrigation methods, agronomic practices, soil and water management practices, problems encountered mode and type of assessment expected.

Economic analysis of irrigation systems was considered for lettuce production per meter squared. Labour was charged at 40 per hour and current average price of lettuce of peri-urban market was fixed at 550 per kilogram. Marginal cost of the systems and labour were considered. All other costs that do not differ across irrigation systems (e.g. costs of planting, transplanting, land purchase and preparation, etc.) will be incurred regardless of the system being used. Labour was charged at 40 per labour per hour manday. Marginal revenue was calculated by subtracting the current market price from the marginal cost of lettuce.

The survey team was made up of agronomists, irrigation engineers, extension agronomists, socio-economists, extension agents on site and expert irrigation agronomists from the United States. Through the study administered by questionnaire, general description of

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irrigation systems, the management, productivity and constraints facing the systems were investigated. How was the data analysed

Results

Biodata Information and Socio-Economic Factors of Dry Season Vegetable Farmers in Southwestern Nigeria.

Farms studied ranged between 0.01-0.33ha in size with average farm size of 0.2 hectare. Farms were relatively smaller within the city (Molete-Bode and Ijanikin-Lagos) than on the outskirts (Table 1). Majority of the farmers (87%) were part time farmers who augment their primary income from off-season vegetable production (Table 2). Eighty percent of the farmers were tenants who rented their field plots annually from landowners (Table 1).

Vegetable Crop Calendar

Dry season vegetables in Southwestern Nigeria are finally harvested between March and April of each year. Thereafter most of the farms become flooded if within the flood plain or fadama because of early rains or are left fallow during the rainy season, May to early September. Land preparation close to a fresh water source is carried out between late September and October, followed by planting operations. Planting are either on the ridges or raised beds depending on the depth of water table and time of the year. A typical cropping calendar for the systems is as shown in Table 3.

Two to three cropping cycles of a particular vegetable is common depending on growth duration, other crops in the mixture and market preferences.

Crops Grown

The major crops cultivated were Lettuce (*Lactuca Sativa*), Cucumber (*Cucumis sativus*), Cabbage (Raphanus Satumus), Carrot (*Dacus carota*), Radish (*Radish botinane*), Amaranthus (*Amaranthus crentus*), Celosia (*Celosia argentea*), Chochorus (*Chrollemus oleotrium*) (Table 4a).

Majority of the farmers' practices (77%) are of intercropping table shows monocropping followed by relay or the other, depending on the types of crop grown and time of the year. The dominant systems are presented in table 4b.

System Management

Weeding was carried out by hand either with hoe or hand pulling depending on the crops grown and cropping systems (Table 4c). For instance, hand weeding was carried out when leafy vegetables were intercropped because their seeds were broadcasted at high density. Pests and diseases especially leaf eating insects were controlled by the application of pesticides and natural plant products (Table 4c). Majority (70-74.0%) of farmers that are closer to cities planted imported seeds from other countries (Table 4d).

Soil Fertility Management

Soil fertility was managed by the application of inorganic fertilizer mainly (NPK 15-15-15), especially on plots that are cropped for up to 2-4 cycle before the end of the season (Table 5).

Water Management

Water conservation management varied from mulching with grasses to reduce loss of water from the system to constructed drainage channels to drain off excess water from field especially at the beginning of the cropping season when the water table is high. Other methods include construction of raised beds, irrigation scheduling, digging of shallow wells and use of watering cans or use of portable petrol water pump during the peak of the dry season (Table 6).water was managed by irrigation scheduling having the highest percent at all locations.

Irrigation Practices

Sources of irrigation water were river, well, borehole, dam and stagnant pool.

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Major source of water was from river at all locations (Table 7). Watering can was the common water conveyance method while others included drainage channels, bucket/basin. The quantity and quality of irrigation water applied were still in the rudimentary stage. Crude way of feeling the soil, observing the crop and soil, as well as farmers' experiences were ways of determining the quantity and quality of water to be applied, however, majority used farmers experience and followed by crop observation (Table 7).

Irrigation Systems Partial Budgeting for Lettuce Production

Table 8 shows the comparison of the productivity of irrigation systems in Southwestern Nigeria. Unit cost of the sprinkler was highest compared to drip or watering can for instance. Total cost was lowest for drip irrigation system, which also had the highest gross benefit (Table 8). Comparing the systems, drip irrigation had the highest net benefit compared with all other systems (Table 8).

DISCUSSION

Water control and soil management are critical for reliable food production. In Africa, only 12 million hectares, about 6% of the total cultivated land are irrigated. This could be increased considerably and irrigation could bring about increase in yield of over 400%. However, this would require policy making which in turn relies on irrigation research (Dada, 2001, IDRC, 1993). Irrigation systems for dry season vegetable production have several advantages if the potentials are fully utilized. From this study it is obvious that farmers in this system try to maximize their resources amidst several abiotic and biotic stresses and socio-economic constraints. But most important of them all is the irrigation system adopted that could deliver optimally the conveyance of water from source to farm.

Most of the cultivated lands were leased which means profitability of the business would have been improved if state laws were in place to address this purpose in favor of the farmers. Moreover this could lead to the increase in the average plot size.

Majority of the farmers (81.9%) were married with children and therefore would maintain a permanent residence in the area of operation and continue the practice if encouraged. Majority of the farmers (64.6%) were also young adults and would still be active in production for a long time. Majority (55.9%) were also illiterate with barely primary education, thus any technology to improve the system must be simple and easily adoptable (Table 2).

The preponderance of leafy vegetables over fruit vegetables suggest that they should be the target of research effort to improve the system. They have shorter life cycle, thereby enables the farmers to have more (2-4) crop cycle before the rainy season. It also defrays costs of field establishment at the beginning of each cropping season.

Majority of the farmers in the system (77%) practiced one form of inter cropping or the other, while hand weeding was most prevalent across the different locations. We noticed with interest that farmers in the city source their seed from imports while peri-urban farmers get their seed from produce or locally suggesting that locally produced seed could be improved upon for export.

About 12% of farmers dig ponds off the stream to store water, but it was observed that dredging of stream during low flow did not adequately control seepage because pond walls were not stabilised. We recorded that 7.8% of the farmers apply organic manure which need be improved upon because Adekalu *et al*. (2001) have shown that soil of Southwestern Nigeria requires adequate soil water permeability during the dry season which organic manure could improve.

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Most farmers (29.6%) use regular intervals of irrigation and control the amount of water used based on their experience and intuition. This is probably because most of the farmers were illiterates and the few literate among them did not study agriculture. Knowledge of initial water holding capacity if lacking does not allow evaluation of water requirement and this often leads to unavailability of water supply, especially during critical periods. Improper and insufficient irrigation scheduling reduces yield and income as was evident in the partial budgeting for lettuce production in this study. The calibration of a bucket evaporator as used in the trickle irrigation system which is similar to that proposed by Torres for the majority of the crops grown by the farmers would serve a useful and simple tool for irrigation scheduling for the farmers. Farmers should be trained in the method of assessing water source to meet irrigation water request and best irrigation requirements, estimation of irrigation water request and best irrigation system to meet farmers' needs.

The main soil conservation practice was the application of fertilizer to improve productivity of the land. Because of the high cost of fertilizer and availability in dear need, an average of 11.9% of the farmers uses organic animal manure. A few practice fallow (4.3%). It was noted that none of the farmers practice in-situ live mulch that could control weed and add nitrogen to soil for instance the use of soyabeans and *sorphocarpus palustris* insitu-live mulch (Ojo *et al*., 2007). It is good that most farmers till their land by making ridges/mounds which further improves permeability of the soil.

The major sources of water used by the farmers were streams (71.5%) and well (21.4%). A very few bore holes or wells in addition to stream water. None used water from dams or stagnant water in the survey. Most of the farmers complained that the flow of the rivers/streams were very irregular and the wells dry up especially during the peak of dry season leading to crop failure and low yield..

A substantial number of farmers (46%) practiced hand watering, although some have petrol engine pump. Though they complained of irregular and fluctuation in prices of fuel, high cost of fuel, and frequent breakdown of the pumps. Very few (14.9%) adopt furrow and basin (drainage channels) irrigation systems. The use of hand watering is laborious and does not produce effective and uniform wetting of the soil. Hand watering also leads to substantial water loss through runoff. The furrow and basin systems are efficient in water distribution, requires less pumping but leads to higher evaporation water loss, lower water use efficiency, and not suitable to all crops. The drainage channel systems are also labour intensive as evidenced in the data presented by comparison of partial budgeting of the different irrigation systems requirements. The use of micro- and macro- trickle irrigation system would reduce the cost of pumping, reduce water loss to evaporation and effective water use efficiency. Use of mulching if employed could further reduce evaporation water losses. Farmer must also be trained in the use of drip or trickle irrigation systems as well as maintenance of water pump.

Conclusion and Recommendation

The best irrigation alternatives that have the greatest chance to work in the time of emergency are those that help small holders move to a substantially higher productivity and income to manage their irrigation system independently in the face of climate uncertainty. The use of drip/trickle irrigation systems, especially micro systems similar to one proposed by Batcher et al. 1996 instead of the sprinkler system, would reduce fuel consumption, cost of pumping and labour, as well as save more water for effective irrigation

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water management usage for dry season vegetable productivity. Bringing small holder irrigation communities in contact with stable, reliable markets for value-added products will help install upward ratchets and readiness/eagerness for irrigation management, inter- and intra-regional market competition for optimal benefits. Construction of stream ponds near the streams, deep wells and stabilized earth ponds near the farm are therefore recommended.

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Table 1: Biodata information on dry season vegetable farmers in Southwestern Nigeria.

	Location				
Biodata	**Molete/Bode**	**Lade/Abeokuta**	**Abanla**	**Akufo**	**Ijanikin/Lagos**
No. of farmers	27	30	18	28	10
No. of farm sampled	12	10	5	8	4
Ave. Farm size (ha.)	0.01	0.25	0.30	0.33	0.02
Land acquisition (%)					
• Owned	x	2	33	50	x
• Leased	90	93	50	17	50
• Rented	10	5	17	3	50
Years spent in farming (%)					
• <10 years	47	24	15	02	45
• 10-15 years	13	58	25	28	07
• >15 years	40	18	60	70	48

*** Indicate no response**

Table 2: Socio-economic factors information of dry season vegetable farmers in Southwestern Nigeria

	Location				
Factors	**Molete/Bode**	**Lade/Abeokuta**	**Abanla**	**Akufo**	**Ijanikin/Lagos**
N*	27	30	18	28	10
Gender Profile (%)					
* Male	85.2	50.0	66.7	75.0	70.0
* Female	14.8	50.0	33.3	25.0	30.0
Marital Status (%)					
* Married	74.1	93.3	83.3	78.6	80.0
* Single	25.9	6.7	16.2	21.4	20.0
Farmers disposition (%)					
* Part Time	82.0	96.0	88.0	80.0	89.0
* Full Time	18.0	4.0	12.0	20.0	11.0
Mean age (%)					
* <30 years	77.8	10.0	33.3	14.3	20.0
* 30-50 years	14.8	90.0	66.6	71.4	80.0
* >50 years	7.4	-	-	14.3	-
Mean No. of Children	14.8	20.0	27.8	17.9	30.0
Education (%)					
* Primary	25.9	73.3	61.1	89.3	30.0
* Secondary	74.1	26.7	38.9	10.7	50.0
* Tertiary	-	-	-	-	20.0

N* = Number of Respondents; - Indicate no response

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Table 3: Vegetable Crop Calendar during the dry season in Southwestern Nigeria

S/No.	Period	Activities
1.	Humid (Mar – Apr)	Final harvest of Irrigated vegetables
2.	Rainy (May – Early Sept.)	Fallow or Submerged Land (if within the Fadama or flood plain)
3.	Early dry (late Sept. – Oct.)	Preparation of land close to a fresh water source for irrigated cropping by preparation of irrigation beds, channels and seedling nurseries.
4.	Dry (Nov. – Feb.)	Growth of 2-3 sequences of relay/intercropped irrigated vegetables.

Table 4: Crops grown and agronomic practices adopted by dry season vegetable farmers in Southwestern Nigeria

	Percent Respondents				
Parameters	**Molete/Bode**	**Lade/Abeokuta**	**Abanla**	**Akufo**	**Ijanikin/Lagos**
N**	**27**	**30**	**18**	**28**	**10**
A. CROPS GROWN					
(*Lactuca sativa*) lettuce	66.7	40.0	55.6	35.7	80.0
(Cucumis sativus) Cucumber	44.4	13.3	22.2	14.3	60.0
(*Apium graveolense*) Cabbage	74.1	13.3	44.4	21.4	90.0
(*Dacus carota*) Carrot	59.3	6.7	11.1	7.1	70.0
(*Raphanus sativus*) Radish	29.6	x	x	x	50.0
(*Amaranthus cruentus*) Amaranthus	14.8	x	22.2	17.9	60.0
(*Celosia argentea*) Celosia	7.4	x	16.7	10.7	x
(*Chrllemus oleotrium*) Chochorus	18.5	66.7	100.0	78.6	80.0
B. Cropping systems					
Monocrop	74.1	86.7	55.6	46.4	70.0
Mixed cropping	x	x	16.7	17.9	x
Relay cropping	25.9	13.3	16.7	28.6	30.0
Inter cropping	x	x	11.1	7.1	x
C. Weeding/Pest control					
Hand weeding	74.1	83.3	55.6	78.6	40.0
Herbicides	x	x	11.1	7.1	20.0
Others	x	x	x	x	x
Insecticides	18.5	6.7	27.8	7.1	20.0
Traps	x	6.7	5.6	7.1	x
Fungicides	7.4	3.3	x	x	20.0
D. Sources of seed					
Local	22.2	20.0	66.7	05	20.0
Imported	74.1	6.7	16.7	02	70.0
Farm produce	3.7	73.3	16.7	21	10.0

****Number of respondents; [x] indicate no response.**

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Table 5: Soil fertility conservation techniques for dry season vegetable Production in Southwestern Nigeria

Techniques (%)	Location				
N*	Molete/Bode (27)	Lade/Abeokuta (30)	Abanla (18)	Akufo (28)	Ijanikin/Lagos (10)
*Fallow	-	13.3	16.7	17.9	-
*Organic fertilizer	7.4	26.7	44.4	35.7	20.0
*Inorganic fertilizer	96.3	93.3	88.9	64.3	100.0
*Zero tillage	3.7	-	-	-	20.0
*Ridging methods	96.3	100	100	100.0	80.0

***Number of respondents; - indicate no respondents**

Table 6: Water conservation management techniques for dry season vegetable production in Southwestern Nigeria

Techniques	Location				
N*(%)	Molete/Bode (27)	Lade/Abeokuta (30)	Abanla (18)	Akufo (28)	Ijanikin/Lagos (10)
*Mulching	-	43.3	66.7	67.9	80.0
*Organic Manure	25.9	6.7	11.1	17.9	40.0
*Irrigation Scheduling	74.1	60.0	88.9	60.7	100.0
*Dug pond	44.4	13.3	5.6	14.3	80.0
*Dredging of streams	29.6	13.3	44.4	28.6	40.0
*Boring of wells	51.9	6.7	72.2	17.9	90.0

***No of respondents; x = indicate no respondents**

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Table 7: Irrigation practices for dry season vegetable production (% of farmers) in Southwestern Nigeria

Techniques	Molete/Bade (27)	Lade/Abeokuta (30)	Abanla (18)	Akufo (28)	Ijanikin/Lagos (10)
* Sources (%)					
- River	92.6	60.0	88.9	78.6	80.0
- Well	7.4	6.7	11.1	14.3	80.0
- Borehole	x	x	x	x	40.0
- Dam	x	x	x	x	x
- Stagnant pool	x	x	x	x	x
*Water conveyance (%)					
- Watering can	85.2	60.0	88.9	82.1	90.0
- Drainage channels	14.8	6.7	27.8	42.9	40.0
- Motorized pump engine	44.4	x	22.2	14.3	90.0
- Hand/Bucket/Basin	14.8	26.7	47.4	35.7	50.0
- Others	x	x	x	x	x
*Water scheduling (%)					
- Feeling the soil	7.4	6.7	11.1	7.1	20.0
- Observing the crop	66.7	53.3	88.9	71.4	80.0
- Experience	92.6	60.0	100.0	92.9	90.0
- Calculation	x	x	x	x	x
- Tensionmeter	x	x	x	x	x

***Number of respondents; x = indicate no respondents**

Table 8: Partial Budget for lettuce production averaged across Urban and Peri-Urban systems dry season of Southwestern Nigeria.

S/N	Irrigation System	Unit Cost (A)	Labour Cost (B)	Total Cost (A+B)	Gross Revenue1 (C)	Marginal Revenue (C-A)	Net Revenue (C-A-B)
1.	Drainage channels	850	400	1,250	5,000	4,150	3,750
2.	Drip/Trickle	450	200	650	6,500	6,050	5,850
3.	Sprinkler	1,200	200	1,400	6,000	4,800	4,600
4.	Watering can	250	800	1,050	5,000	4,750	3,950
5.	Bucket/basin	200	800	1,000	5,000	4,800	4,000

Note: 158 Nigerian Naira (#) = One US dollar
Lettuce = #550/kg; One hour manday = #40/hour; 10,000m2 = One hectare.
[1]Gross Revenue = Field proice/kg X average yield (kg/m2); where field price is the market value of one kg of lettuce to the farmer.
[2]Marginal Revenue = This was calculated by subtracting the unit cost of the system from the Gross Revenue.
[3] Net revenue = This is calculated by subtracting the labour cost from the Gross Revenue.

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Improving Post-Harvest Vaselife of Cut Heliconia (cv. 'Golden Torch') Flowers Using Organic Floral Preservatives

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Abstract
Post-harvest longevity of Heliconia (cv. Golden Torch) cut flowers using organic floral preservatives is becoming an increasing study in order to replace synthetic floral preservatives with eco-friendly and cost effective organic materials. Investigation of Aloe vera as floral solution for Heliconia cut flowers was carried out in the Floriculture laboratory of National Horticultural Research Institute, (NIHORT); Ibadan, Nigeria (7 25"N and 3 52"E). Treatments include Aloe vera solution at ten different concentrations (1% – 10%) v/v denoted as AV1 – AV10 respectively. The control (C) was tap water. The experiment was arranged in a completely randomized design (CRD) with four replicates. Data collected was analyzed using SAS software. From the results obtained, there was significant difference (P<0.05) in the relative weights of the cut flowers with the highest records observed by AV4 (74.97) which was not significantly different from AV9 (74.72) while the lowest was observed with AV2 (50.28). There was significant difference in the relative water content (RWC) of the cut flowers; AV4 gave the highest value at 87.27 while AV7 gave the lowest at 46.19. The pH values also show that the treatments were slightly alkaline. Vase life of Heliconia (cv. Golden Torch) Cut flowers was extended for more than 7 days with Aloe vera floral solution. This is a good indication that Aloe vera gel solution can be used effectively as organic floral preservatives for the longevity of cut flowers.
Keywords: Aloe vera, longevity, eco-friendly preservatives, cut flowers, Heliconia

INTRODUCTION

Heliconia flowers are brightly beautiful and colourful and are most planted for ornamental purposes. Many species of the genus *Heliconia* (Heliconiaceae family) are found in all tropical regions of the world due to their horticultural and commercial popularity. Cut *Heliconia* flowers are well known for their beauty, different shapes and impressive colors (Andreza *et al*., 2011). The beauty of cut flower lies in the freshness of the flowers for longer time without losing its aesthetic value. All along the marketing channel, there is enormous loss in the value of cut flowers which could be 50 per cent of the farm value (Bhattacherjee, 1999). Cut flowers of most ornamentals have relatively short lives. Their delicate flowers are easily damaged, and are often highly susceptible to wilting. The cut flowers, after being detached from the mother plant are deprived of their natural resources of water and nutrient, as a result their life processes are at the expense of reserved food materials. Hence, addition of substances as foral preservatives to the cut flowers is recommended to continue its physiological processes so that the longevity of the flowers can be extended by more number of days (Nair *et al*., 2003). The desirable to improve the longevity of cut flowers for commercial purpose has always been the goal of florist and most research on cut flowers. The vase life of cut flowers depends on quite a number of variables such harvesting conditions, packaging, physiology of the plant and the holding solution but to mention a few. One of the factors responsible for this short lived span of cut flowers is senescence (Yamada *et al*., 2003). Many chemicals have been used in cut flowers vase solutions for inhibiting microorganisms' growth, which extends the vase life by improving water uptake. These chemicals include silver nitrate, aluminum sulphate, 8-hydroxyquinoline sulphate and 8-hydroxyquinoline citrate.

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Because of the toxicity of most chemicals and environmental pollution caused by them, the use of natural compounds that have no side effects on human health, the environment and that are at relatively low cost is very important (Okigbo and Ikediugwu, 2005). *Aloe vera* (*Aloe barbedensis*) is an ever green plant with succulent and fleshly spiny leaves filled with clear viscous gel. *Aloe vera* is widely distributed throughout the tropics and subtropics. *Aloe vera* is widely known for its high medicinal values, as it possesses high antimicrobial, antifungal and preservative properties. The exudate, called 'aloes' or 'bitter aloes', is contained in the pericycle cells of the vascular bundles in the leaf (PROTA, 2008). *Aloe vera* is often grown as an ornamental in gardens or pots. *Aloe vera* gel used in coating on grapes lengthens the shelf life considerably and this method could also be applicable in other high-value fruits, vegetables and ornamentals. Biological and eco-friendly materials are being researched for as alternatives for synthetic chemical floral preservatives (Prasad and Elumalai, 2011). Hence this study is carried out to investigate the effect of *Aloe vera* gel as floral preservatives at various concentrations on the vase life of *Heliconia* (Golden Torch) cut flowers.

MATERIALS AND METHODS

Experimental site and Plant materials

This study was carried out at the Floriculture laboratory of the National Horticultural Research Institute (NIHORT) Ibadan, Nigeria (7 25"N and 3 52"E). Flowering stems of *Heliconia spp.* with three to five open bracts were harvested in the early morning from the floriculture garden, NIHORT. The leaves on the lower section of the stems were removed and the stems were cleaned and kept in water for some minutes until the commencement of the experiment.

Experimental design and Data collection

The experiment was arranged in a completely randomized design (CRD) with four replicates under a temperature of 25 ± 2 C, 70% relative humidity and 150 µmol m^{-2} s^{-1} light intensity from cool-white fluorescent lamps with a light/dark cycle of 12/12 hours. Eleven treatments were used as floral solutions for the study. These include ten concentrations of *Aloe vera* gel solutions at (1% – 10%) v/v without sucrose, denoted as AV1 - AV10, respectively. The control (C) was tap water. Data collected was analyzed using Analysis of Variance (ANOVA) while the significant differences among treated means were computed using least significance difference (LSD) test at 5% level of significance.

Relative weight and Relative water content

The relative weight was calculated as a ratio, and to determine the weight, a spike from each treatment was weighed daily (Petridou *et al*., 2001). Leaf relative water content (RWC) from each sample was determined according to the method described by (Barr and Weatherley 1962). To measure the RWC, 2 – 3 excised petals per plant were weighed (fresh weight, FW) and placed in water for 6 hours to allow them reach full turgidity, thus, the turgid weight (TW) was determined. The leaves were then dried at 60°C for 24 hours and their dry weight (DW) obtained. With these, the RWC was calculated using the formula: $\%RWC = (FW - DW) / (TW - DW) \times 100$

Vase life

Vase life was determined as the time period for which a spike of cut flower retained 50% fresh flowers.

RESULTS AND DISCUSSION

There was significant difference ($P<0.05$) in the relative fresh weight of the cut flowers at day 3. While some of the treatments had a slight drop in the fresh weight of the flowers, treatments AV4, AV6, AV7 and AV9 showed an increase

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in the relative fresh weight of the flowers as seen in (table 1). By day 12, the highest record (74.98%) was observed by AV4 floral treatment, while the lowest (50.28%) was recorded by AV2. The Relative water content (RWC), as seen in table 2, showed significant difference (P<0.05) with AV4 having the highest RWC of 87.27% while AV7 recorded the lowest value of 46.19% compared with the control that had 50.03%.

Table 2 shows that there was significant difference (P<0.05) in the pH values of the floral solutions. AV10 recorded the highest pH of 7.33 compared with the control that had 6.95. There was significant difference (P<0.05) in the wilting of the petals by day 12. Only two treatments; AV4 and AV8 did not show complete wilting of the petals (table 3).

The fresh weights of the cut flowers were seen to increase slightly after a few days in some treatments as seen in table 1. This could be due to the absorption of solution through the xylem of the flowers; however the weights dropped as the study proceed. Gomes *et al.*, (2010) reported that water imbalance within the vascular cells of cut flowers results in wilting and termination of vase life. This was confirmed as the cut flowers experienced wilting towards the latter part of the experiment. At day 12, compared with the control, treatments AV3, AV4, AV8 and AV9 were significantly higher (P<0.05) with AV4 recording the highest value of 74.97%.. The relative water content (RWC) is an index indicating the amount of water held in the plant organs and shows the ability of the plant in maintaining water especially under stress conditions (Abbaszadeh *et al.*, 2008).Table 2 shows that there was significant difference (P<0.05) in the RWC of the cut flowers with AV4 having the highest RWC of 87.27%. Aloe vera solutions have been reported by Adebayo *et al.*, (2017) to increase the RWC of *Heliconia* cut flowers. Aloe vera exudate contains the secondary metabolite called 'aloes' or 'bitter aloes' which is present in the pericycle cells of the vascular bundles in the leaf (PROTA, 2008). This may likely be responsible for the slight alkalinity (as shown in table 2) of the solutions and for the decrease in microbial growth. Table 3 shows the wilting sequence of the petals. The vase life of cut flowers is directly reflected on the petals freshness. There was no significant difference in the fresh petals of the cut flowers in most of the treatments but at day 12 most of the flower petals had wilted save only AV4 and AV8. Aloe vera generally improve the shelf life of Heliconia cut flowers as compared with the control and this is in line with the reports of Mirzakhani and Jalali, (2015) and Adebayo *et al.*, (2017) who reported that application *Aloe vera* gel treatment has been shown to significantly increase the vase life of cut flowers of Anturium *andranum* and Ixora *coccinea* respectively.

CONCLUSION

The challenges of replacing synthetic chemicals as floral preservatives by organic solutions can be achieved through the use of Aloe vera gel solutions at 4 – 8% as alternative to synthetic floral preservatives. More research should be encouraged to see how best it can be used even with other supplements.

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Table 1: Relative fresh weight of *Heliconia* cut flowers (%)

TRT	DAY 3	DAY 6	DAY 9	DAY 12
CO	91.65	84.34	70.66	60.6
AV1	81.95	67.52	59.67	51.87
AV2	88.06	78.59	66.45	50.28
AV3	95.46	87.13	75.82	69.53
AV4	113.56	103.65	89.53	74.98
AV5	92.74	83.66	75.46	61.8
AV6	100.22	87.71	75.79	57.11
AV7	100.74	80.38	72.02	62.9
AV8	94.98	89.25	82.81	69.53
AV9	101.05	98.2	88.23	74.72
AV10	91.12	79.56	69.3	59.34
$LSD_{0.05}$	19.31	16.71	18.08	17.29

$LSD_{0.05}$: Least significant different at 5% probability

Table 2: Relative water content and pH of *Heliconia* cut flowers.

TRT	CO	AV1	AV2	AV3	AV4	AV5	AV6	AV7	AV8	AV9	AV10
RWC (%)	52.02	76.46	74.93	67.88	87.27	70.65	70.98	46.19	77.49	77.78	63.62
pH	6.95	7.13	7.07	7.05	7.2	7.24	7.29	7.3	7.27	7.17	7.33

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Table 3: Opened petals of *Heliconia* cut flowers

TREATMENT	DAY 3	DAY 6	DAY 9	DAY 12
CO	100	33.33	28.21	0
AV1	100	100	100	0
AV2	100	100	100	0
AV3	100	100	100	0
AV4	100	100	100	85.72
AV5	100	100	100	0
AV6	100	100	100	0
AV7	100	100	100	0
AV8	100	100	100	88.89
AV9	100	100	100	0
AV10	100	66.67	66.67	0
$LSD_{0.05}$	ns	*	*	**

$LSD_{0.05}$: Least significant different at 5% probability

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Assessment of Different Food- based Attractants and Methyl eugenol for Trapping the Oriental Fruit Fly, *Bactrocera dorsalis* (Diptera: Tephritidae) on Guava Homestead Trees

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Abstract
Fruit fly infestation is one the major constrains militating against fruit production and export in Africa. The study assessed catches of oriental fruit fly ,Bactrocera dorsalis Hendel complex in Lynfield traps baited with three food –based attractants; Torula yeast, pineapple juice, brewery waste and methyl eugenol (para-pheromone lure) on guava homestead trees during 2017 fruiting season in Ibadan, Nigeria. The traps were randomly hung on three selected guava trees at 5 -10 m from the ground (within the tree canopies) at three locations. The population of fruit flies caught were recorded at weekly interval for ten consecutive weeks. Data collected were transformed using square root transformation (X+0.5) then subjected to analysis of variance (ANOVA) and significant means were separated at 5% level using the Turkey's Honestly Significant Difference (HSD). The results showed that Bactrocera dorsalis were trapped at all the locations. There were significant differences ($p<0.05$) among the attractants on the population of flies trapped per location. Methyl eugenol was the most effective in trapping B. dorsalis in all the locations with mean range (4.94 -7.95)/trap/10weeks, followed by brewery waste (2.04 - 4.39/trap/10week). Methyl eugenol trapped only male flies while brewery waste and other food based attractants trapped both male and female flies. Brewery waste was the most effective among food -based attractants and has shown great promise in attracting B. dorsalis. Hence, it can be incorporated by farmers for the management of B. dorsalis on fruits and vegetables since it is relatively cheap, readily available and environment- friendly.
***Key words**: Oriental fruit fly, trapping, food bait, guava, lures, attraction*

INTRODUCTION

The Orieintal fruit fly, *Bactrocera dorsalis* Hendel (Diptera: Tephritidae) is an agricultural pest of Asian origin that are invasive in many countries in the globe including Nigeria. The pest is found throughout Asia, including Bhutan, southern China, India and Thailand, and has been recorded from over 173 host species in the world (White and Elson-Harris 1992).

The *Bactrocera dorsalis* complex comprises more than 75 species, and is one of the most economic important pest complexes in the world of agriculture (Clarke *et al*., 2005). The pest is highly polyphagous and highly invasive with *B. dorsalis* (Hendel) being regarded as a pest of major bio-security concern (CABI, 2015; Clarke *et al*., 2005; EPPO, 2015). There has been argument for many years concerning some species of the *B. dorsalis* complex, especially the status of *Bactrocera papayae* Drew & Hancock, *Bactrocera philippinensis* Drew & Hancock, *Bactrocera invadens* Drew, Tsuruta & White and *B. dorsalis*, with various authors suggesting that these species should be considered as one (Tan *et al*., 2011; Krosch *et al*., 2013; San Jose *et al*., 2013). In 2014, *B. papayae, B. philippinensis and B. invadens* were finally incorporated into *B. dorsalis* (Schutze *et al.,* 2015a, b).

In 2003, *B. dorsalis* was recorded for the first time in Kenya and at that stage it was described as a new species, *Bactrocera invadens* (Lux *et al.,* 2003; Drew *et al*., 2005). The pest was first reported in Nigeria in 2005 (Umeh *et al*., 2008; Vayssières *et al*., 2008; Asawalam and Nwachukwu, 2011; EPPO, 2014). *B.*

dorsalis has played a direct role in hindering the development of a gainful and expanded tropical fruit industry (Vargas *et al,.* 2000).According to Vargas *et al.* (1983) 95% of *B. dorsalis* population develops in common guava, *Psidium guajava* L, and strawberry guava, *P. cattleianum* Sabine and the population cycles are determined mostly by wild guava fruiting.

Marketable and garden fruits are harshly damaged by *B. dorsalis* increases in nearby guava area. Damage is done when female flies lays egg under the skin of fruit; consequently the larvae feed inside the fruit, leading to decay and wide-ranging crop losses (Ekesi and Billah, 2007; James and Schiffers, 2007; Vayssières *et al*., 2008). The occurrence of *B. dorsalis* in parts of Africa has also led to major economic losses due to loss of market access (Ekesi *et al.,* 2011).

Traditionally, fruit flies have been managed in agricultural areas using protein bait sprays. Female flies need protein for full ovarian development and egg production, thus they readily feed on a protein source containing a toxicant. The bait spray strategy significantly reduces the amount of pesticide needed for fruit fly control and has been used successfully in eradication campaigns (Roessler, 1989). According to Mediouni-Ben *et al*., (2010) the use of the mass trapping technique through female-targeted and male-targeted lures can also be included as a component of an Integrated Pest Management (IPM) program for Fruit flies. Nagaraj *et al*., (2014) reported that sanitation combined with the use of traps and lures and synthetic protein food baits has shown to be one of the best alternatives for the control of fruit flies. However, Bjelis (2006) earlier reported that mass trapping of fruit flies show better efficacy over bait sprays and has lower cost of application especially human labour. Therefore, the objectives of this study are to assess the efficacies of three food- based attractants in trapping *B. dorsalis* and to compare their efficacy with Methyl eugenol in mass trapping of *B. dorsalis* complex on guava homestead trees.

MATERIALS AND METHODS

Experimental site

The study was carried out in Ibadan, Oyo state South west Nigeria during the 2017 guava fruiting seasons. Ibadan is located within latitude within latitude 7 22' N and longitude 3^0 54' E of Greenwich Meridian Time (GMT) with annual rainfall of about 1300 to 1500mm and average relative humidity of about 80 to 85 % (FRIN, 2014).

Ibadan has eleven Local Government Areas (LGAs) and three LGAs were selected as experimental sites for the study. They include: Ibadan North East Local Government (J. Allen Avenue), Ibadan North West Local Government (Idi-ishin) and Ibadan South East Local Government (Apata). Three locations were selected from each LGAs.

Collection and preparation of brewery waste

Brewery waste was collected early in the morning from Nigerian brewery Alakia, Ibadan Oyo State, Nigeria, Twenty Kilogram of fresh brewery waste was poured inside an aluminium pot and placed inside another pot containing water. The setup was placed on a gas cooker and boil at for 15hrs consecutively. It was observed for colour change, when the colour changes from light brown to deep brown, the heating was discontinued and allowed to cool for 2 hours. It was later served with the aid of muslin cloth to collect a brown homogenous solution called hydrolyzed crude protein.

Preparation of Pineapple food bait: Pineapple food bait was prepared by peeling 1 Kg of the fruit and blending it into smooth slurry paste using an electric kitchen blender. The juice was extracted with 1 liter of water and sieved with

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muslin cloths to obtain a homogenous solution. The sample was refrigerated until when used.

Experimental set up

Lynfield trap (LT) was used in this study. Lynfield trap is a bucket type trap composed of a cylindrical plastic container with four equidistant holes on the upper third and the lid of the trap contains a hook to which an ME dispenser such as Invader Lure must be fitted (Copeland, 2012) There were five treatments including control; they include Methyl eugenol, Pineapple juice bait, hydrolyzed crude protein from brewery waste, Torula yeast and control (water). Cypermethrin (2 mls) was added to each attractant to knock down the trapped flies. Three trees were selected from each location and a distance of 10 m separated each tree to obtain three independent replicates within each location. Forty millilitres of prepared food baits were taken with aid of 10ml injection syringe and carefully dropped on a 0.5 gm of absorbent cotton wool and placed at bottom of the trap while twenty millilitres of Methyl eugenol was used following the same procedure and each treatment was replicated three times per location in a Complete Randomized Block Design (CRBD) using each tree as a sampling unit. Five traps were hung on each tree at 10 m above the ground within the tree canopy.

Data collection and analysis

Data were collected on the number of fruit flies trapped per trap every week in all the locations for ten weeks consecutively. The trapped flies were brought to the laboratory for counting, identification and sexing. Data collected were transformed using square root transformation ($X + 0.5$), then subjected to Analysis of Variance (ANOVA) and significant mean was separated at 5% level using the Turkey's Honestly Significant Difference (HSD).

RESULTS

Effects of treatments on the density of *Bactrocera dorsalis* trapped on Guava at Apata

The result showed that Methyl eugenol was the most effective attractant in trapping *B. dorsalis* at Apata (Fig. 1). It recorded mean population density of 5.67 (49.40%) of adult *B. dorsalis* per trap after 10 weeks. This was followed by hydrolyzed protein bait made from brewery waste with mean density of 3.54 (30.84%) per trap at 10 weeks. The weekly catches of flies by the attractants per trap revealed that Methyl eugenol significantly ($p<0.05$) trapped the highest number of flies throughout the period of the study. The density of the *B. dorsalis* trapped declined as the fruiting season passes out. Highest populations of flies were recorded at the peak of fruit ripening from 3rd – 6th week in June

Effects of treatments on the density of *Bactrocera dorsalis* trapped on Guava at J. Allen

The population density of *B. dorsalis* recorded at J. Allen avenue followed similar trend with that of Apata. Highest population of *B. dorsalis* were trapped on Methyl eugenol with mean density of 7.95 (60.30%) per trap in 10 weeks (Fig. 2). It was followed by hydrolyzed protein bait from brewery waste with mean density of 4.39 (33.30%) per trap in 10 weeks. Methyl eugenol significantly ($p<0.05$) caught higher number of *B. dorsalis* flies from week one to week ten. Brewery waste significantly ($p<0.05$) caught higher number of *B. dorsalis* than other food based attractants. The control trapped did not catch any *B.dorsalis* flies throughout the period of the experiment. The peak density of flies were also recorded at the high point of fruit ripening from 3rd - 6th week (June) during the study.

Effects of treatments on the density of *Bactrocera dorsalis* trapped on Guava at Idishin

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The population density of *B. dorsalis* tapped by the different attractants at Idishin is shown in Fig. 3. Methyl eugenol significantly ($p<0.05$) recorded the highest number of *B. dorsalis* flies throughout the study period with a mean density of 6.80 (63.10%) per trap in 10 weeks, followed by hydrolyzed protein bait from brewery waste with mean value of 2.54 (23.61%). There were no significant differences ($p>0.05$) among the pineapple juice, torula yeast and the control baited traps on the density of flies trapped in this location with the control trap recording zero. *B. dorsalis* density were similarly higher from 3rd – 6th week (June) during the study in this location.

Percentage population of *B. dorsalis* trapped on Guava homestead trees at the three Locations of the study areas

Bacterocera dorsalis were trapped in all the three study sites selected for the study (Fig. 4)

There were no significant differences ($p \geq 0.05$) on the population density of *B. dorsalis* trapped in all the locations. However, J. Allen avenue trapped the highest percentage of *B.dorsalis* (37.22%) followed by Apata (32.40%) while the Idishin location trapped the least population density of *B. dorsalis* flies (30.36%)

Percentage density of male and female *B. dorsalis* trapped on Guava homestead trees at the three study sites.

Male and female *Bacterocera dorsalis* were trapped in all the study sites selected for the study (Fig. 5)

Methyl eugenol trapped only males *B.dorsalis* at the three study sites while food- based attractants trapped both male and female flies. The percentage density of male *B.dorsalis* trapped by methyl eugenol was significantly ($p<0.05$) higher than other treatments. Hydrolyzed protein from brewery waste significantly ($p< 0.05$) trapped higher number of females than other food -based attractants. There were no significant differences ($p>0.05$) among the densities of males trapped by the food based attractants.

DISCUSSION

The study has shown that all the food – based attractants tested attracted adult *B. dorsalis.* However, the level of attraction varied with the different attractants evaluated. This corroborates the earlier report by Vargas *et al*. (2003) who reported that the type of protein in a food-based bait can influence the attractiveness of the bait to fruit flies. All the food-based attractants caught both male and female adult *B.dorsalis* while methyl eugenol trapped only male flies. This corroborates the earlier study by Ekesi *et al*. (2014) who reported that various food attractants tested in his experiments were able to attract both sexes of *B. dorsalis* in mango but the level of attraction varied with the different protein baits. Protein source as an important constituent in the food baits and commercial lures has been used to trap *B. cucurbitae* (Satpathy and Samarjith Rai, 2002; Fabre *et al*., 2003) and *B. dorsalis* (Alyokhin *et al*., 2000 ; Cornelius *et al*., 2000). Similarly, Rajitha and Viraktamath (2005) also reported attraction of female fruit flies to protein food baits in guava and mango orchards. According to Christenson and Foote (1960) female fruit flies requires protein source to ensure fecundity. Epsky *et al*. (1999) reported that protein source has been exploited in developing attractants for female fruit flies and protein bait acted as a food attractant to immature female fruit flies (Allwood, 1997).

Methyl eugenol a para pheromone outperformed the food based attractants evaluated in terms of attractiveness to *B. dorsalis* and trapped only male flies while hydrolyzed protein bait from brewery waste were moderately effective and trapped both male and female *B. dorsalis* This report support the earlier report by Russell Messing (1999) that

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parapheromone lures (methyl eugenol, cue-lure, ceralure, trimed lure and latilure) attract only males and every fruit fly species in Hawaii is attracted to a different kind. In that order, Ekesi *et al.* (2014) reported that Methyl eugenol is a male annihilation lure for *B. invadens* and it attracts only males

Bactrocera dorsalis was trapped on guava homestead trees in all the locations during the study, indicating that guava is among the primary host of *B. dorsalis* complex. This confirms the earlier report by Goergen *et al* (2011) that among cultivated fruits with at least 10 samples, *B. dorsalis* infestation index was highest for guava, mango, and citrus fruits. Similarly, Vargas *et al.* (1983) earlier reported that 95% of *B. dorsalis* population develops in common guava, *Psidium guajava* L, and strawberry guava, *P.cattleianum* Sabine and their population cycles are determined mostly by wild guava fruiting. All the location this study recorded incidence of *B. dorsalis* which reveals the presence of B. dorsalis in Ibadan and its environs. This study affirms the earlier report by Umeh *et al.,* (2008) that *B. dorsalis* has been recorded on mango and citrus in Nigeria. It has earlier been reported that the host range of *B. dorsalis* in Africa consists of more than 72 plant species of both wild and cultivated crops spread across 28 families (Goergen *et al.,* 2011; Umeh and Onukwu, 2016).

CONLUSION

This study has contributed to the knowledge and presence of of *B. dorsalis* in Nigeria. Guava has proved to be one of the major host of *B. dorsalis* and that protein bait from brewery waste has shown to be potential for mass trapping of *B. dorsalis* .This is important for the development of efficient management strategies against the pest. The strong and selective response of *B. dorsalis* to Methyl eugenol, and food – based attractants and the capacity to infest and develop in guava fruits were confirmed by this study.

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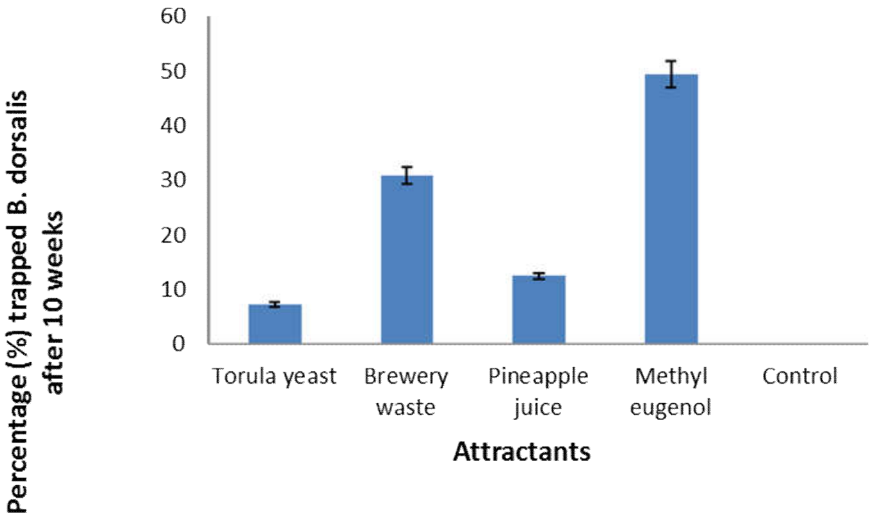

Fig.1.Effects of the treatment on the population density of *Bactocera dorsalis* trapped at Apata.

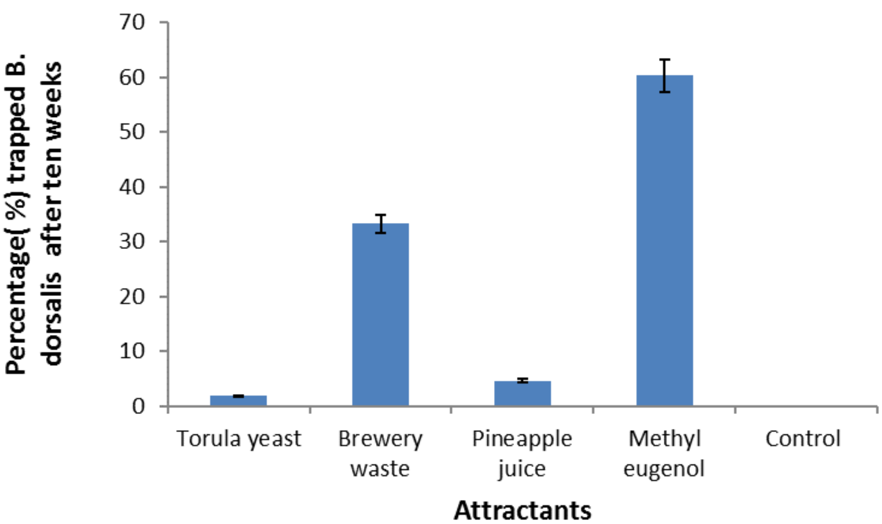

Fig. 2. Effects of the treatment on the population density of *Bactocera dorsalis* trapped at J. Allen Avenue

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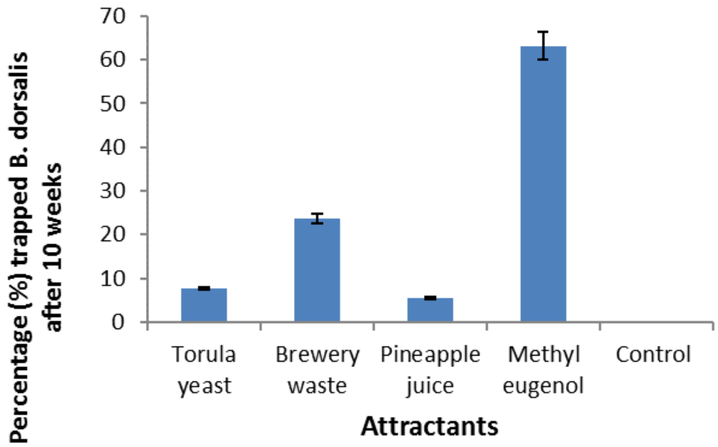

Fig. 3.Effects of the treatment on the population density of *Bactocera dorsalis* trapped at Idishin.

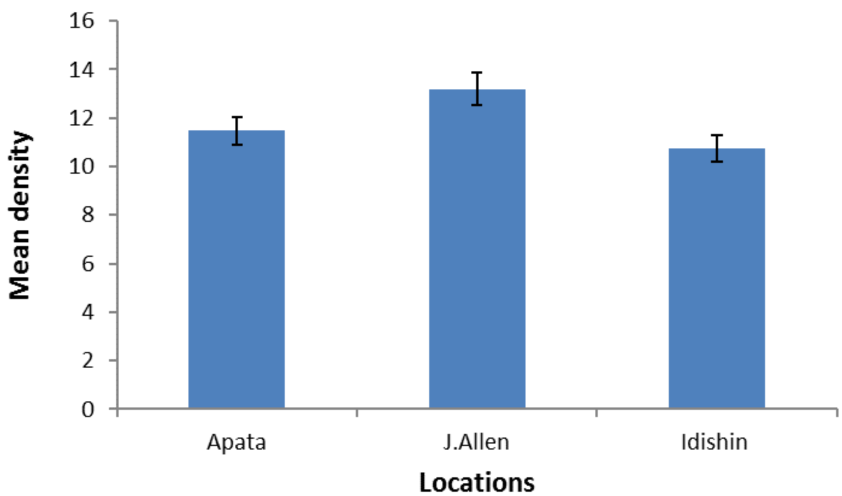

Fig. 4.Mean population of *B. dorsalis* trapped on Guava at the three study areas

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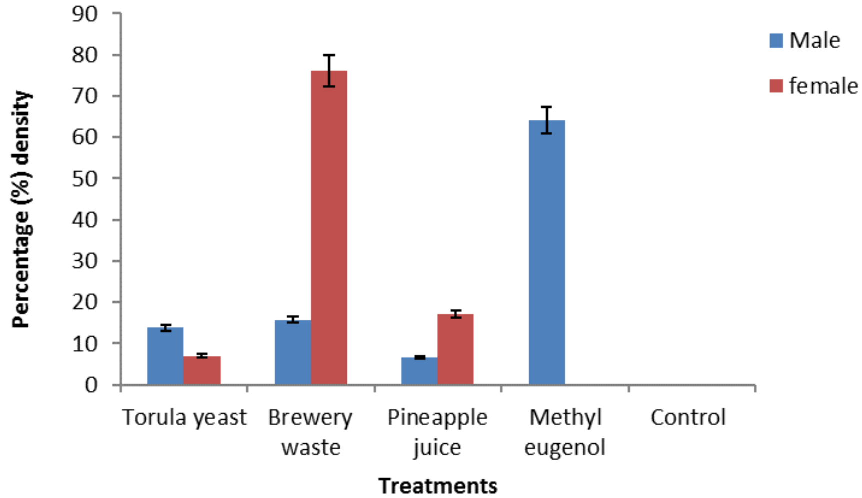

Fig.5. Percentage density of male and female *B. dorsalis* trapped at the three study sties

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Improving Post-Harvest Vaselife of Cut *Heliconia* (cv. 'Golden Torch') Flowers With Silver Thiosulphate Solution (STS) Floral Preservatives

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Abstract
Maintaining the quality, freshness and beauty of cut flowers remain one of the challenging problems faced by florists and researchers. This study was carried out to evaluate the effect of Silver thiosulphate (STS) as floral preservatives for Heliconia (cv. Golden Torch) cut flowers. The experiment was carried out in the Floriculture laboratory of National Horticultural Research Institute, (NIHORT); Ibadan, Nigeria (7 25"N and 3 52"E). Ten (10) treatments consisting of five different concentrations of STS solutions at (1% – 5%) v/v denoted as STS1 – STS5 respectively, without sucrose and another portion of same concentrations supplemented with 2% sucrose denoted as STSS1 – STSS5. The control (C) was tap water. The experiment was arranged in a completely randomized design (CRD) with four replicates. Data collected was analyzed using SAS software. From the results obtained, floral STS treatments without sucrose extended the vase life of Heliconia cut flowers for up to four days compared with those with sucrose. At 12 days, all cut flowers in treatments supplemented sucrose were completely wilted. There was significant difference (P<0.05) in the relative weights of the cut flowers with the highest record observed with STS3 (87.39) while the lowest was observed with STS7 (54.26). Though treatments without 6ucrose were significantly different, the highest numbe.

INTRODUCTION

The cut flowers industry is one of the major industries in floriculture. Cut flowers have short vase life and mostly are used freshly, so their vase life improvement is one the prime importance in flower trade and users. *Heliconia* (Golden torch) is a brightly beautiful cut flower. Many species of the genus *Heliconia* (*Heliconia*ceae family) are found in all tropical regions of the world due to their horticultural and commercial popularity (Albuquerque *et al*., 2014). Cut *Heliconia* flowers are well known for their exotic beauty, different shapes and impressive colors, resistance to handling, transport and increased durability (Andreza *et al*., 2011). Normally, their postharvest vase life is about 6 – 7 days. After harvest the longevity of cut flowers is limited by rapid petal wilting. The major reasons for shorten vase life of cut flowers are; nutrient deficiency, bacterial and fungal contaminations, water stress-induced wilting and vascular blockage which is caused by the accumulation of microorganisms in solution, air embolism and physiological response of the plant to cut stem (Ichimura *et al*., 1999). When the vessel is blocked, the transpiration process occurs continuously and there is no net gain of water by flower stem. In order to increase the vase life of cut flowers, various combinations of chemicals as floral preservatives are used. The presence of sucrose in preservative solutions improves the quality and longevity of postharvest cut flowers, but increases microorganisms' growth which impede the flow of water through the stem (Fahima and Inayatullah (2013). So along with the use of sugar, the antimicrobials should be used in the preservative solutions of cut flowers. Ethylene has been found to play a pivotal role in senescence of ethylene sensitive flowers (Shahri and Tahir, 2010). After harvest the longevity of flowers is limited by rapid petal wilting. Floral preservatives have been found to delay senescence by suppressing the microbial growth and promoting solution

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uptake due to reduction in vascular blockades (Elhindi, 2012; Asrar, 2012). The use of ethylene antagonist such as Silver Thiosulfate Solution (STS) and floral preservative (8-Hydroxy quinoline sulphate) will therefore allow for a better adjustment of flowers supply to the requirements of the market and to a greater extent eliminate the postharvest losses. In the light of this, we carried out this study to investigate the effect of STS at various concentrations on the vase life of *Heliconia* cut flowers.

MATERIALS AND METHODS

Experimental site and Plant materials

This study was carried out at the Floriculture laboratory of the National Horticultural Research Institute (NIHORT) Ibadan, Nigeria (7 25"N and 3 52"E). Flowering stems of *Heliconia spp.* with three to five open bracts were harvested in the early morning from the floriculture garden, NIHORT. The leaves on the lower section of the stems were removed and the stems were cleaned and kept in water for some minutes until the commencement of the experiment.

Experimental design and Data collection

Eleven treatments were used as floral solutions for the study. These include five concentrations of Sliver thiosulphate (STS) solutions at (1% – 5%) v/v without sucrose denoted as STS1 – STS5 respectively, and another five treatments of same concentrations supplemented with 2% sucrose denoted as STSS1 – STSS5 respectively and the control (C) which was tap water. The experiment was arranged in a completely randomized design (CRD) with four replicates under a temperature of 25 ± 2 C, 70% relative humidity and 150 μmol m^{-2} s^{-1} light intensity from cool-white fluorescent lamps with a light/dark cycle of 12/12 hours. Data collected was analyzed using Analysis of Variance (ANOVA) while the significant differences among treated means were computed using least significance difference (LSD) test at 5% level of significance.

Relative weight and Relative water content

The relative weight was calculated as a ratio, and to determine the weight, a spike from each treatment was weighed daily (Petridou *et al*., 2001). Leaf relative water content (RWC) from each sample was determined according to the method described by (Barr and Weatherley 1962). To measure the RWC, 2 – 3 excised petals per plant were weighed (fresh weight, FW) and placed in water for 6 hours to allow them reach full turgidity, thus, the turgid weight (TW) was determined. The leaves were then dried at 60°C for 24 hours and their dry weight (DW) obtained. With these, the RWC was calculated using the formula: %RWC = (FW – DW) / (TW – DW) × 100

Vase life

Vase life was determined as the time period for which a spike of cut flower retained 50% fresh flowers.

RESULTS AND DISCUSSION

From the results there was significant difference ($P<0.05$) in the relative fresh weight of the cut flowers (figure 1) with the application of STS solutions supplemented with and without sucrose. The highest value was recorded by STS2 (108.63) at day 6, while the lowest was recorded by STSS1 (54.81) at day 12. At day 6, STS2, STS3 and STS4 showed increased weight as compared to other treatments. By day 12, most of the cut flowers had decreased significantly in weight; however, STS3 gave the highest value of relative fresh weight at 87.39. Jalili Marandi, *et al*., (2011) mentioned that various preservative solutions including SA, STS and Ajowan oil, were efficient treatment for keeping cut gladiolus flowers fresh weight at optimum level. In our study STS (without sucrose) tends to have higher fresh weights of

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Heliconia cut flowers as at day 12 compared to the control. This may be due to the fact that the presence of sugar in solution makes the solution hypertonic hence over time the plant loses its water which in turn reduces it weight and turgidity. Gomes *et al*., (2010) reported that water imbalance within the vascular cells of cut flowers results in wilting and termination of vase life. Table 2 shows that there was significant difference (P<0.05) in the opened petals of *Heliconia* cut flowers with the different floral solutions. The main ornamental parts of a cut flower are the petals, sepals, and bracts. Turgidity of these parts depends largely on water uptake. With decreased water uptake over time, the turgidity and fresh weights of the cut flowers depreciated as seen in table 1. The vase life of cut flowers is directly reflected on the freshness of the petals. Arora *et a*l., (2007) noted that wilting of plant parts is also due to senescence resulting from depleted plant nutrient, flaccidity of the cells and enzymatic processes. By day 9, the vase life of the cut flowers had dropped and even the control was already at 33.33. By day 12, all STSS treatments as well as the control was completely wilted, while others except STS3 (65.58) showed fresh petals below 50% (bench mark for vase life of cur flowers). This is in line with the report of Adebayo *et al*., (2017), that floral preservative of Aloe vera solution without sucrose reduces wilting of petals compared to those supplemented with sucrose. The relative water content (RWC) is an index indicating the amount of water held in the plant organs and shows the ability of the plant in maintaining water especially under stress conditions (Abbaszadeh *et al*., 2008). There was a significant difference (P<0.05) in the relative water content of the cut flowers (Table 3). The highest value (63.91) was recorded with STS3 while the lowest was recorded with STSS3 (23.14) as compared with the control (32.40). Treatments consisting of STS alone had higher RWC than treatments of STS supplemented with sucrose (2%). Shahri and Tahir, (2011) reported that the use of ethylene antagonist Silver Thiosulfate Solution (STS) and other floral preservative has been shown to reduce the postharvest losses of cut flowers. And this corresponds with our results as STS floral preservatives were able to extend the vase life of *Heliconia* cut flowers.

CONCLUSION

The vase life of *Heliconia spp* cut flowers was extended by the use of Silver thiosulphate (STS) solutions in this study. STS without sucrose supplement was effective in reducing post-harvest loss than sucrose supplemented STS solutions.

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Table 1: Relative fresh weight of *Heliconia* cut flowers (%)

TRT	DAY 3	DAY 6	DAY 9	DAY 12
CO	91.65	84.34	70.66	60.6
STS1	103.03	91.87	83.08	66.57
STS2	103.05	108.63	97.73	80.7
STS3	88.84	103.45	96.66	87.4
STS4	97.73	104.44	90.74	73.75
STS5	92.01	85.93	78.74	61.82
STSS1	85.23	77.37	64.4	54.81
STSS2	99.51	82.21	69.25	54.27
STSS3	97.73	79.33	67.54	58.45
STSS4	100.36	91.87	70.57	54.93
STSS5	86.71	81.12	85.93	68.3
$LSD_{0.05}$	14.65	30.05	21.4	16.3

$LSD_{0.05}$: Least significant different at 5% probability

Table 2: Opened petals of *Heliconia* cut flowers

TREATMENT	DAY 3	DAY 6	DAY 9	DAY 12
CO	100	100	33.33	0
STS1	100	100	83.1	43.98
STS2	100	100	88.38	48.74
STS3	100	100	95.83	65.58
STS4	100	94.44	60.14	39.8
STS5	100	100	96.97	31.42
STSS1	100	66.67	55.01	0
STSS2	100	100	69.63	0
STSS3	100	96.97	90.91	0
STSS4	100	94.44	81.67	0
STSS5	100	97.22	67.22	0
$LSD_{0.05}$	ns	32.46	32.28	14.19

$LSD_{0.05}$: Least significant different at 5% probability

Table 3: Relative water content of *Heliconia* cut flowers.

TRT	CO	STS 1	STS 2	STS 3	STS 4	STS 5	STSS 1	STSS 2	STSS 3	STSS 4	STSS 5
RWC (%)	32.40	45.28	40.21	63.91	58.83	56.05	31.53	33.11	23.14	34.43	41.44

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Storability of Fruits of Two Sweet Orange Varieties as Influenced by Edible Oil Coatings at Makurdi, Nigeria

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Abstract
A study to investigate the influence of edible oil coatings on the storability of fruits of two sweet orange varieties was conducted in April, 2018 at Makurdi, Nigeria. The seed oils were incorporated in carboxylmethylcellulose with glycerol added as plasticider. Treatments comprised two sweet orange varieties (Ibadan Sweet and Valencia), two edible seed oils (Moringa seed oil, MSO, and sesame seed oil, SSO) and oil concentration (0%, 1% and 2%). Factorial combinations of the factors were laid out in completely randomized design and replicated three times. Fruits were coated with the seed oils according to treatment and kept under ambient conditions in the laboratory. Physical changes in terms of weight loss, firmness and percent decay were monitored at 5-day intervals up to 30 days of storage. Results showed a general increase in weight loss with storage duration and a progressive decline in weight loss as oil concentration increased. Variety and oil type had no significant effect on fruit weight loss. Fruit firmness increased with storage duration with Ibadan Sweet and MSO giving more firm fruits towards the end of the storage period. Oil concentration did not show any clear significant effect on fruit firmness. Fruits of the cultivar Valencia recorded higher percentage decay than those of Ibadan Sweet. There was a progressive decrease in fruit decay as oil concentration increased from 0 – 2%. Significant second order interactions with respect to weight loss were observed.
Key words*: Storability, Edible coatings, Sweet orange.*

INTRODUCTION

Postharvest food losses are an issue of global concern, while quantitative losses are of greater concern in the developing world; and developed countries accord greater priority to losses in quality of food products (Kader, 2005). Although, accurate estimates of postharvest food losses are difficult to come by, FAO predicts that on global scale, 1.3 billion tonnes of food produced is lost annually (Gustavsson *et al*., 2011). Kader (2005) posits that losses in fresh fruits and vegetables in developing countries vary between 1 and 50% or even higher in some instances. Reduction in these losses will make more food available for human consumption thereby enhancing food security(Aulakh *et al*.,2013) and increasing incomes of the producers (World Bank, 2011).

Citrus, grapes and banana are considered the three major fruits in the world with an annual production of about 80 million tonnes each (Aubert and Vullin, 1998). Citrus in particular has witnessed a global steady rise in production with Nigeria occupying the 9th position among the 140 countries producing the crop (UNCTAD, 2010). Benue State, adjudged the leading producer of citrus within the country (Avav and Uza, 2002) normally experience enormous postharvest losses during the main harvest season.

The use of edible coatings in fruit storage is expected to reduce moisture loss, respiration and escape of flavour volatiles (Jongun, 2002) thereby increasing shelf life. Commercial citrus production have traditionally utilized waxes as fruit coating material to reduce fruit weight loss, restrict shrinkage and improve appearance (Parat *et al*., 2004; Bajwa and Anjum, 2007). Commercial citrus waxes are however often amended with synthetic chemical

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antimicrobial agents particularly fungicides.

With rising concern for food safety and consumer health, there have been increasing interest in the evaluation of natural biodegradable substances, particularly edible oils, as possible alternative coatings in the storage of fruits. The objective of this study was therefore to assess the effectiveness of moringa(*Moringa oleifera*) and sesame (*Sesamum indicum*) seed oils at various concentrations in the storage of fruits of two sweet orange varieties under ambient conditions.

MATERIALS AND METHODS

Sweet orange fruits freshly harvested from two stands (Ibadan sweet and Valencia) from Vandeikya Local Government Area of Benue State, were placed in plastic crates and transported under cool weather to Makurdi, in April, 2018. Oil was extracted from dried seeds of moringa and sesame using local cold press extraction method. 1g carboxylmethylcellulose (CMC) was dispersed in 100ml distilled water while 0.5% (v/v) glycerol was added as plasticider. The fruits were first immersed in a solution of sodium hypochlorite (1%, v/v) for 5 minutes to sterilize them and later rinsed with portable water and left to air dry for 1 hour.

Treatments were made up of variety (Ibadan Sweet and Valencia), edible oil types (Moringa seed oil (MSO) and Sesame seed oil (SSO) and oil concentrations of 0%, 1% and 2%. The 0% acted as the control (no treatment). The experiment was a 2x2x3 factorial arranged in completely randomized design (CRD) and replicated three times. Each experimental unit had 36 fruits. Fruits were dipped in the oil concentrations according to treatments and kept in plastic crates under ambient conditions at the Biology Laboratory of the Benue State University, Makurdi. Monitoring of the physical parameters was done at 5-day intervals up to 30 days of the fruit storage. Fruit firmness was measured using penetrometer.

Data collected were subjected to analysis of variance (ANOVA) while significant means were separated using the least significant difference (F-LSD) procedure at 5% probability level.

RESULTS

Table 1 presents main effects of treatments on weight loss of fruits. Weight loss was found to increase as the storage period advanced. Variety and oil type had no significant effect on weight loss of fruits throughout the storage period. Significant effect was observed with respect to oil concentration. An inverse relationship existed between oil concentration and fruit weight loss.

Effect of treatment on fruit firmness is summarized in Table 2. A trend of increasing fruit firmness with duration of storage was observed. Ibadan Sweet fruits appeared more firm at the last recorded interval compared with Valencia. Fruits coated with MSO were also more firm than those coated with SSO. Firmness with respect to oil concentration was not consistent.

Percent fruit decay was significantly influenced by variety (Table 3). Fruits of Ibadan Sweet variety experienced less decay than those of Valencia throughout the study period.Oil type did not exert any significant influence on fruit decay although MSO showed a tendency to reduced decay better than SSO. With respect to oil concentration, a clear pattern of reduced fruit decay was observed with increasing oil concentration. Generally, fruit decay increased as the storage period progressed.

Significant interactions among the 3 factors were observed with respect to fruit weight loss (Table 4).When Ibadan Sweet

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fruits were coated with MSO, weight loss was less at 1% concentration. With SSO, weight loss was less at 2% oil concentration up to 15 days of storage. At 30days, there was no statistical difference in weight loss between fruits coated with 1% or 2% SSO. Both concentrations were better than the control. Valencia fruit coatings with MSO at concentrations 1 and 2% proved better than the control. At 30 days of storage, 1% MSO resulted in lower fruit weight loss than the 2% concentration.

DISCUSSION

Weight loss is a common occurrence in fruits during storage (Wills *et al*., 1981).The use of oil coatings in this study appeared to lessen the extent of weight loss. The higher fruit weight retention conferred by increasing concentration of the edible oil coatings might be due to their effect on fruit skin permeability characteristics. Obviously, higher amounts of oil were able to exert greater sealing effect on the fruit skin surface, thereby reducing moisture loss. However, the fact that Ibadan Sweet fruits experienced less weight loss at 1% MSO concentration compared to 2% indicates that this response could depend on oil type andcrop variety.

The pattern of increasing fruit firmness with advancing storage as observed in this study is contrary to established pattern in fruits (Moistofi and Toivonen, 2006).Generally, fruits are expected to become softer as storage progresses. In the case under consideration, weather conditions at the time of the experiment were still very much dry and must have had overbearing influence on fruit firmness. Ibadan Sweet fruits were firmer than those of Valencia probably because the former possess a thicker rind (skin) than the latter.

Similarly, the lower fruit decay recorded by Ibadan Sweet variety could be attributed to skin characteristics. Valencia, unlike Ibadan Sweet, has a thinner skin which makes it more vulnerable to fruit decay. The fact that MSO showed greater tendency to reduce fruit decay merits further investigation

Fruit decay was inversely related with oil concentration. The oil coatings must have formed a semi-permeable barrier against the movement of materials (Park, 1999) capable of predisposing fruits to spoilage. In another sense, these oils could possess antimicrobial activity capable of greatly limiting the capacity of spoilage organisms. Antimicrobial properties of MSO (Wang *et al*., 2016) and SSO (Arumkumar *et al*., 2009) have been reported.

This study has established the better storability attributes of Ibadan Sweet variety over Valencia and more enhanced storability with use of edible oils. With Ibadan Sweet variety, lower concentration of moringa seed oil (1%) appears more beneficial.

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Table 1. Main Effect of Treatment on Percentage Weight Loss of Fruits of 2 Sweet Orange Varieties at Makurdi, Nigeria in 2018

Treatment	Days in Storage						
	0	5	10	15	20	25	30
Variety							
Ibadan Sweet	0.0	12.3	20.2	23.7	26.4	28.9	32.2
Valencia	0.0	8.0	17.2	20.0	23.1	26.3	29.3
LSD $_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS
Oil Type							
MSO	0.0	9.3	19.0	21.7	24.5	27.6	30.
SSO	0.0	10.9	18.4	22.1	24.9	27.6	31.4
LSD $_{(0.05)}$	NS	NS	NS	NS	NS	NS	NS
Oil Concentration							
0%	0.0	13.2	21.0	23.6	26.3	29.0	33.3
1%	0.0	8.6	19.0	23.2	26.0	28.6	31.5
2%	0.0	8.6	16.0	18.8	21.9	25.2	27.4

LSD (0.05)	NS	NS	NS	NS	NS	3.35	3.50

MSO = Moringa seed oil; SSO = Sesame seed oil; NS = No significant difference

Table 2. Main Effect of Treatment on Fruit Firmness of 2 Sweet Orange Varieties at Makurdi, Nigeria in 2018

Treatment	Days in Storage						
	0	5	10	15	20	25	30
Variety							
Ibadan Sweet	2.8	6.8	9.5	10.6	12.0	12.1	14.1
Valencia	3.8	6.6	8.9	10.9	12.2	12.2	13.6
LSD (0.05)	0.23	NS	0.45	NS	NS	NS	0.24
Oil Type							
MSO	3.3	6.5	9.5	11.3	12.1	12.4	14.1
SSO	3.3	7.0	8.9	10.2	12.1	11.9	13.5
LSD (0.05)	NS	0.34	0.45	0.29	NS	0.18	0.24
Oil Concentration							
0%	3.3	6.1	9.1	10.6	11.9	10.2	13.7
1%	3.3	6.5	9.1	10.7	12.1	13.0	13.8
2%	3.3	7.6	9.4	11.0	12.2	13.2	14.0
LSD (0.05)	NS	0.29	NS	NS	NS	0.22	NS

MSO = Moringa seed oil; SSO = Sesame seed oil; NS = No significant difference

Table 3. Main Effect of Treatment on Percent Decay of Fruits of 2 Sweet Orange Varieties at Makurdi, Nigeria in 2018

Treatment	Days in Storage						
	0	5	10	15	20	25	30
Variety							
Ibadan Sweet	0.0	0.0	0.3	0.9	2.0	4.3	6.2
Valencia	0.0	0.0	0.9	1.6	3.2	4.6	7.9
LSD (0.05)	NS	NS	NS	NS	1.14	NS	1.50
Oil Type							
MSO	0.0	0.0	0.5	0.9	2.5	4.5	6.3
SSO	0.0	0.0	0.8	1.6	2.8	4.5	7.7
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS
Oil Concentration							
0%	0.0	0.0	1.6	3.7	6.7	9.5	12.7
1%	0.0	0.0	0.0	0.0	1.2	2.1	5.3
2%	0.0	0.0	0.0	0.0	0.0	1.9	3.0
LSD (0.05)	NS	NS	1.36	0.96	1.39	1.75	1.84

MSO = Moringa seed oil; SSO = Sesame seed oil; NS = No significant difference

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Table 4. Interaction Effect of Treatment on Percent Decay of Fruits of 2 Sweet Orange Varieties at Makurdi, Nigeria in 2018

Variety	Oil Type	Oil Conc	Days in Storage						
			0	5	10	15	20	25	30
Ibadan Sweet	MSO	0%	12.0	11.2	11.2	12.2	13.1	12.5	14.1
		1%	12.0	9.9	10.3	11.2	11.1	10.1	12.1
		2%	12.0	13.2	11.3	12.3	12.1	14.2	14.2
	SSO	0%	12.6	13.6	13.5	14.5	15.9	15.9	17.1
		1%	12.6	14.2	13.3	14.3	13.7	13.2	15.3
		2%	12.6	12.1	13.2	13.3	15.1	14.3	15.5
Valencia	MSO	0%	12.0	12.0	10.3	12.3	15.5	16.1	14.2
		1%	12.0	10.8	10.8	11.6	14.0	12.2	11.1
		2%	12.0	11.4	10.3	11.2	12.0	11.4	13.1
	SSO	0%	12.6	11.6	12.2	14.2	17.1	13.5	13.1
		1%	12.6	13.8	13.2	15.2	17.5	12.0	14.5
		2%	12.6	14.2	14.2	14.3	14.9	14.6	15.3
$LSD_{0.05)}$			NS	1.23	0.47	0.45	0.32	0.28	0.31

MSO = Moringa seed oil; SSO = Sesame seed oil; NS = No significant difference

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Evaluation of The Efficacy of Some Plant Extracts For The Control of Insect Pests Attack on *Telfairia occidentalis* During Dry Season Planting in Okigwe, Imo State, Nigeria.

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Abstract
Studies on the efficacy of some plant extracts for the control of insect pest attack on leafy Telfairiaoccidentalis were conducted during dry season planting from Nov.2017 to March 2018 at National Horticultural Research Institute (NIHORT) Mbato, Okigwe Out Station in Imo State. The treatments were aqueous solution of leaf extracts of Vernoniaamygdalina, Moringaoleiferia,Azadirachtaindica, Carica papaya seeds and mixture of the named plant extracts and Control. Telfairia seeds were sown in the nursery and four weeks after sowing, seedling were transplanted at a spacing of 1 x 1m on Experimental plots of 9m^2 arranged in a randomized complete block designwith three replications. Data collected on the populationof flying insects of Zonocerusvariegatus, Podagricauniforma and P. sjodesti were subjected to ANOVA and significant means were separated using LSD at 5% probability level . Results showed significant differences (p 0.05) between the treatments and control on the mean number of identified insect pest population with mixture of the solution recorded to be more effective following Azadiraclntaindia, VernomiaamygdalinaandPapaya seed in reducing the population of Zonocerusvariegatusand P. sjodestiand P.uniforma, respectively. Moringaoleiferia show less effective in reduction of insects population for 1 week of application (WOA) and 3 weeks of application(3WOA), respectively while control recorded highest number of insect pest in all the weeks of applications. So the tested aqueous plant extracts prove effective in the control of major insect pest on leafy Telfairiaoccidentalis.
Keywords: Telfairiaoccidentalis,Plant extracts, Efficacy, Insect pest.

INTRODUCTION

Telfairia (*Telfairia occidentalis* Hook F.) commonly known as fluted pumpkin belongs to the family curcubitaceae (Akanni*et al.,* 2005) and is one of the most widely cultivated vegetable in southeastern Nigeria (Akoroda, 1990). Its cultivation has gradually spread into Northeastern Nigeria because of the economic importance of its leaves and seeds in the world market (Hortnews, 2005) as well as it nutritional content when used as vegetables. The leavesareknown to be important sources of protein, vitamins, and mineral when consumed. Apart from this, it provides an appreciable income to small scale farmers (Akoroda, 1990). The edible part of the crop includes the tender shoot, leaves, petiole and seeds that are usually cooked (Akoroda, 1990). The leaf has a high nutritional, medicinal and industrial values rich in protein(29%), fat (18%), minerals and vitamins (20%) (Badiru and Ogunsua,1991).The vegetable is also very effective in the treatment of cough, diarrhea, tuberculosis and other bacterial infections (Ebomeji *et al*., 2006). The plant has beneficial effects on the lipid profile with antilipidaemic effects including blood cholesterol and protection from associated complication like cardiac problems, hypertension and diabetes (Uguru*et al*.,2011). He reported that the shoot contains high level of potassium and iron.Because of the importance of this crop, insect pests and diseases complex constitute majorbiotic factors militating against increase in production from the farmers. Insect pests are reported to accounts for the reduced yield and loss between40-55% of the crop could occur (Onekutu, 2011). It is also observed that extreme loses are usually high in dry season planting than rainy season planting when weather condition interfere with the crop protection measures. The serious insect pests of this crop in southeastern Nigeria is the *Zonocerus variegatus* and

Podagrica spp. These insects feed on the leaves with their mandible mouth parts modified for chewing. In other to control these insect pests, farmers are currently using too much toxic chemicals and applying them frequently to control the pests. This excessive pesticide usage threatens the health of farmers and consumers, besides making the vegetable more costly to consumers. The over usage of synthetic insecticide has reportedly caused some pests to become tolerant to these insecticides, thus, making them more difficult to control. In the recent past, efforts have been intensified to control the associated insect pests of *Telfairia* using synthetic insecticides such as Cypermethrin, Lambdacyhalothrin, Deitamethrin and promising result were obtained (Ibekwe,1997) . The hazardous effect of these pesticides has increasingly become a major source of concern to environmentalists. Thus other options for the management of insect pests become imperative. The use of botanicals is more acceptable to the farmer because of general safety and ease of handling (Emeasor, *etal*., 2005). However, the search for more sustainable non-conventional method using plant derived insecticides that are environmentally safe with simple application techniques for control of insect pests like *Z*. variegatus,*P. uniforma* and *P. sjodesti* on the leafy *T. occidentalis* gave rise to the decision to carry out this study .The objective of the study was to contribute to increase in the production of the leafy *T. occidentalis* by reducing infestation of *Z. variegatus* and *P. uniforma* through application of locally available plant materials that are environmentally friendly, cheaper and using simple application techniques that are always available.

MATERIALS AND METHODS

This study was conducted at the National Horticultural Research Institute (NIHORT), MbatoOkigwe Imo State during the dry season at the experimental field with replicate of three times in Randomized Complete Block Design (RCBD). Treatments consisted of moringa (*Moringa oleiferia)*, Bitter leaf (*Vernonia amygdalina)*, Neem (*Azadirachta indica)* andPawpaw (*Carica papaya)* seeds extract in aqueous solutions with mixture of all the aqueous**.**

Collection, Preparation and Application of the Plant Extracts

The leaves of *V. amygdalina, A. indica, M. oleiferia and seeds of C. papaya* were sourced from NIHORT premises, Local markets and nearby bushes. The plant materials were thoroughly washed with distilled water to remove soil and other debris. After which the materials were ground with pestle and mortal. 1kg each of the plant materials were soaked with 4 liters of water and allowed to infused overnight (12hrs). Thereafter, the mixture was sieved using muslin cloth placed in a funnel. The concentrations were made up to 4 litres after which they were applied manually using 2 litrescapacityvolpi hand sprayer. The treatment commenced two weeks after transplanting and was done at weekly intervals for six weeks.

Data Collection and Analysis

Insect collection and identification started two weeks after transplanting. These were done weekly intervals using a sweep net of size 30cm diameter and 75cm depth in the early hours of the day (6-7.30am). The aim is to identify highest number of insects pest that damage fluted pumpkin leaves in OkigweL.G.A.Imo State, Nigeria. All data collected were subjected to Analysis of Variance (ANOVA) and the mean were separated using Least Significant Difference (LSD) at 5% probability level.

RESULTS AND DISCUSSION

Results(Table 1-4) show the effect of some plant materials on the mean number of identified insect pests attacking *T. occidentalis* in Okigwe southeast Nigeria. The results, also show the collected insect

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pests to include variegated grasshopper(*Zonocerusvariegatus*)and Beetles(*Podagricauniforma and P.sjodesti).* All the treatments(plant extracts) significantly (p≤0.05) reduced the insect pests infestation population on *T. occidentalis* than the control. In Table 1 there was no significant difference (p≥0.05) among the plant extracts and the control. This is because there is no application of the treatment in this table. From Table2 to Table4, there were significant (p≤0.05) differences between the plant extracts from the control. However,*V. amygdalina* was found to be highly effective followed by *A. indica,M. oleiferia, seeds of C. papaya* and the mixture(Table2-4) while control recorded the highest mean number of the insect pest population.

Moreover in (Table 3) the mixture of all the plant extracts recorded highest significant different on reducing the population of*Z. variegatus* up to zero and *M.oleiferia* recorded highest significant difference in reducing *P.uniforma* and also *A. indica* and mixture recorded highest significant difference in reducing *P.sjodesti* in population on the field more than the others. This agreed with Adenbigbe*et al*. (2007) that spices and some plants extracts contain compounds known as phyto-chemicals which have insecticidal properties that are alkaloids in treatment of several diseases and insect control.

There were no significant (P<0.05) differences between *V. amygdalina, A. indica, C. papaya* seedand *M. oleiferia* extracts in their efficacy in controlling the insect pests of *T. occidentals* (Table 2-4). *Morigaoleiferia* recorded high significant difference among the others in controlling *P.uniforma* (Table 3). This present result is in line with Emeasor, K.C and Uwalaka, O. A(2015).who reported that insecticides of plant origin namely, *M. oleifearia*, *A. indica* extracts obtained very high percentage reduction in damage caused by insect pests.This making plant derived insecticides complementary to synthetic insecticide in the control of insect pests. These findings also agree with Ramos *et al*. (2006) who observed that leaf extracts of botanicals showed some degree of insecticidal properties (ovicidal and larvicidal) against insect pest population.

I also observed that all aspects of number of mean population of the insect pest in plots sprayed with the plant extracts were not significantly different from that of mixture but were significantly different (P<0.05) from the control.

CONCLUSION/RECOMMENDATION

Plant extracts tested, significantly (P<0.05) reduced the population of the pests when compared with the control plots. Their applications resulted to decrease in the mean population of insect pest, thereby increase the growth and yield of the *T. occidentalis* except for control. The effect of these applications also increases the market value of *T. occidentalis* for the farmers.

This result has however proven that insecticide of plant origin (bio-insecticides) could be used as alternatives to the synthetic insecticides since their applications relatively competedfavourably with the synthetic insecticides and they were not found to be toxic to human or plant.

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Table 1: Effect of treatment application on mean population of identified insect pest attacking *Telfairiaoccidentalis* in Okigwe. Before application.

Treatment	Z variegatus	P. uniforma	P. sjodesti
V. amygdalina	2.33	1.67	1.33
M. oleiferia	2.33	1.33	2.00
A. indica	2.33	2.33	2.00
C. papaya seed	3.00	1.67	0.67
MTN	1.78	1.67	2.00
Control	3.00	2.67	2.00
Mean	2.52	1.89	1.67
LSD	1.14	1.08	1.33

Table 2: Effect of treatment application on mean population of identified insect pest attacking *Telfairiaoccidentalis* in Okigwe. 1 WAA..

Treatment	Z variegatus	P. uniforma	P. sjodesti
V. amygdalina	1.00	1.00	1.33
M. oleiferia	2.00	1.00	1.33
A. indica	1.67	1.33	1.00
C. papaya seed	1.33	1.00	1.00
MTN	2.00	1.00	1.00
Control	3.33	2.00	1.67
Mean	1.61	1.22	1.22
LSD	0.67	0.43	1.03

Table 3: Effect of treatment application on mean population of identified insect pest attacking *Telfairiaoccidentalis* in Okigwe 2 WAA.

Treatment	Z variegates	P. uniforma	P. sjodesti
V. amygdalina	0.33	0.33	0.00
M. oleiferia	0.67	0.00	0.33
A. indica	0.33	0.67	0.00
C. papaya seed	0.67	0.67	1.00
MTN	0.00	0.33	0.00
Control	2.33	2.00	2.33
Mean	0.72	0.67	0.61
LSD	0.92	0.88	0.64

Table 4: Effect of treatment application on mean population of identified insect pest attacking *Telfairiaoccidentalis* in Okigwe 3WAA.

Treatment	Z variegates	P. uniforma	P. sjodesti
V. amygdalina	1.33	0.33	0.33
M. oleiferia	1.00	1.00	1.00
A. indica	1.00	0.67	0.67
C. papaya seed	1.33	0.33	0.00
MTN	0.89	1.00	0.67
Control	2.67	1.33	1.00
Mean	1.37	0.78	0.61
LSD	0.69	0.92	0.92

Fungi Associated with Post Harvest Rot and Seedling Infection of Tomato (*Solanum lycopersicon* L.) from Otukpo and Makurdi Local Government Areas of Benue State, Nigeria.

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Fungi associated with post harvest rot and seedling infection of tomato(*Solanum lycopersicon* L.) from Otukpo and Makurdi Local Government Areas of Benue State, Nigeria

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Abstract
This study was carried out to identify fungal pathogens associated with post harvest deterioration of fresh and dried tomato fruits in Makurdi and Otukpo Local Government Areas (LGAs)of Benue State, Nigeria and their effects on tomato seedling infection. Samples of fresh and dry tomato fruits were collected and cultured on Potato Dextrose Agar in completely randomized design replicated three times. Four different fungi were found associated with the rot of fresh and dried tomato fruits namely Aspergillus flavus, Lasiodiplodia theobromae, Pythium sp.and Colletotrichum capsici.Pythium sp had the highest rate of occurrence of 40.00 %,Aspergillus flavus (26.67 %), B. theobromae(13.33%) and Colletotrichum capsici (6.67 %). Aspergillus flavus and Pythium sp.were isolated from fresh and stored tomato fruits and seeds while B. theobromae and C. capsici was isolated from stored tomato seeds.Aspergillus flavus infected 63.00 % of the tomato seedlings, Lasiodiplodia theobromae (30.00%), Pythium sp (17.00%) and C. capsici (12.00%).The presence of these fungi on fresh and dried tomato fruits indicates the need for management of fungi and improved farm sanitation to prevent store to field transmission of these pathogens.
***Keywords**: Aspergillus flavus,Lasiodiplodia theobromae, Pythium sp.,Colletotrichum capsici tomato .*

INTRODUCTION

Tomato (*Solanum lycopersicon* L.*) is a member of the* family S*olanaceae* widely consumed in both raw and processed forms in soups and cooked foods (Moneruzzaman *et al*., 2008). It is used in many dishes, salads, sauces and drinks and can also be dried and ground into pancakes (Effiuwevwere, 2000).The tomato fruitis rich in vitamins A and C, carbohydrates, proteins, fats, fibres, potassium and lycopene which prevents breast andprostate cancer and decreases the risk of cardiovascular diseases (Freedman, 2008).

In Nigeria tomato is produced mainly in the Northern States of Nigeria with less rainfall (Dento and Swarup, 1983). Tomato production and economic value is relatively affected byits short shelf life resulting from pathogen attack.Tomato contains large amounts of water which makes it more susceptible to spoilage by the action of microorganisms (Onurah *et al*., 2015).

Tomato rots are a common cause of tomato loss due to reduction in the quantity and quality of tomato during sale and storage (Dongondaji *et al*., 2005).Farmers' effort to increase tomato production in Nigeria has been consistently hampered by rot resulting in little or no profit since most tomatoes are lost after harvest.

Microbiological examination of tomatoes is necessary toidentifycontaminatingfungi that produce toxins harmful to man and determine how to control them. Thecontamination of tomato seeds by fungi usually leads to disease development in the field when the infected seeds are planted and may result in disease epidemics and scarcity of tomatoes for consumption.Spoilage of tomatoes usually results in changes in taste, smell, appearance or texture of the fruits (Singh, 2007). Losses of up to 50% can occur in tomatoes between the harvesting and consumption in tropical countries (Pila *et al*., 2010).

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Althoughtomato rot fungi have been investigated in some parts of Nigeria (Ijato *et al*., 2011; Wogu and Ofuase, 2014; Bello *et al*., 2016), there is dearth of information on the fungi responsible for tomato rot in Makurdi and Otukpo Local Government Areas of Benue State.

Furthermore, the scarcity of tomatoes experienced in Nigeria in 2016 necessitated the need toassess the fungal pathogens limiting tomato seedling health and those fungi contaminating dried tomatoes which, are often used as alternatives during scarcity.This study was therefore carried out to identify fungal pathogens associated with post harvest deterioration of fresh and dried tomato fruits in Makurdi and Otukpo Local Government Areas of Benue State, Nigeria and their effects on tomato seedling infection.

MATERIALS AND METHODS

Study Area

The study area was Makurdi Local Government Area of Benue State, Nigeria located on latitude 7^{o} 44'1.50'' N; longitude 8^{o} 31'17.00'' E; 104 m above sea level and Otukpo Local Government Area on latitude 7^{o} 12'60 N ; longitude 8^{o} 08'60 E in the Southern Guinea Savanna agro - ecological zone of Nigeria. The two Local Government Areas were selected based on tomato production status in Benue State, Nigeria (RMRDC, 2012).

Collection of Sample

Fresh and dried local tomato cultivar fruits showing signs of deterioration and softness were randomly purchased from three selling points in the major markets in Makurdiand Otukpo Local Government Areas of Benue State, Nigeria in June 2016. The fruits were packaged separately and transported to the Plant Pathology laboratory of Federal University of Agriculture, Makurdi in sterile sample bags for fungal isolation.

Isolation of fungi

Infected fruits and seeds were used for isolation of the fungi. Small section of 3-5 mm^2 where cut from the infected fruits to contain both diseased and healthy looking tissues (Agrios, 2005). The tissue pieces were sterilized for 1minute in 1% sodium hypochlorite solution and rinsed in three changes of sterile distilled water (SDW) and blotted dry on sterile filter papers. The sterile pieces were placed on 9cm sterile Petri dishes containing Potato Dextrose Agar (PDA) to which streptomycin Sulphate was added at the rate of 0.2g/L to prevent bacterial contamination. The experiment was set in a complete randomized design with three replicates. A total of one hundred seeds were plated per Local Government Area giving a total oftwohundred seeds. The dishes were incubated at ambient conditions of light and temperature (30± 2 °C) for 3 days after, which pure cultures were obtained by sub - culturing on to fresh PDA plates. Pure cultures were identified using a compound microscope at x10 – x 100 magnificationsand compared with reference manual (Watanabe, 2010). The pure cultures of the fungi were identified on the basis of their colony growth pattern and conidial morphology. The fungi identities were authenticated at the Germplasm and Health laboratory of International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria.

Pathogenicity test on tomato fruits

Pathogenicity test was carried out on the fungi isolated from tomato fruits to confirm the pathogenic organisms. The pathogenicity of four isolates namely: *Aspergillus flavus, Lasiodiplodia theobromae, Pythium spp* and *Colletotrichum capsici*was tested *in vivo* on detached ripe, healthy tomato fruits using theagar plug method of inoculation (Ekhuemelo *et al*., 2016). Apparently healthy ripe tomato fruits were surface sterilized with 1% Sodium hypochlorite

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for one minute and washed in three changes of sterile distilled water. A 3mm cork borer was used to punch into the healthy tomato fruits and the bored tissues were removed. A 1mm cork borer portion from pure cultures ofisolated fungi was aspetically placed in the hole and covered with the tissue to prevent the entry of other fungi. Inoculated fruits consisted of three tomato fruits per isolate in three replicates.Control consisted of asterilized 1mm PDA disc placed in the holes of the healthy tomato fruits. The fruits were incubated for one week at room temperature (30± 2^{o}C). Inoculated fruits were subsequently observed for rot development. The pathogenicity of each fungus was determined by measuring the extent of rot (cm) on the infected fruits.

Data collection

The rot lesion induced by each fungus was rated as mild, moderate or severe on the tomato fruits using the method of (Ekhuemelo *et al*., 2015). The percentage seedling infection by inoculated fungi was determined as the number of infected seedlings as a percentage of the germinated seedlings. Fungal growth rate was based on the time taken by the fungus to cover the whole plate of Petri dish using the method of Go *et al*. (2015) where:

Very fast growth = within 5 days
Medium growth = 10 to 15 days
Fast growth = 5 to 10 days Slow growth = 15 to 20 days

Statistical Analysis

All the data were subjected to analysis of variance (ANOVA) using SAS software (SAS, 2009). Significant means were separated using Fisher's least Significant Difference (F-LSD) at 5 % level of probability.

RESULTS

Identification and Pathogenicity of Isolated Fungi

Data presented in Table 1 shows the percentage occurrence and pathogenicity of fungal isolates from tomato fruits from Otukpo and Makurdi LGAs of Benue State. *Pythium* sp and *Aspergillus flavus*were found in tomato fruits and seeds of from Makurdi and Otukpo LGAs with 40.0% and 26.7%percentage occurrence respectively.*Lasiodiplodia theobromae* had a percentage occurrence of 13.3% in tomato seeds from Otukpo LGA and*Colletotrichum capsici*was isolated from tomato seeds from Makurdi LGA with the lowest percentage occurrence of 6.6%. *Pythium*sp. was more pathogenic inducingsevere soft rot symptoms on tomato fruits, A. *flavus* and *C. capsici* were less pathogenic with moderate rot infection while *B. theobromae* had least pathogencity with mild rot infection.

Data presented in Table 2 shows the macroscopic and morphology of isolated fungi. *Lasiodiplodia theobromae* had abundant fluffy greyish white mycelium and grew very fast covering the 90 mm Petri dish within 3-4 days. *Aspergillus flavus* and *Pythium* sp. produced typical green and white colour respectively with a fast growth rate. *Colletotrichum capsici* grew at a medium rate producing light grey mycelium with concentric ring of acervuli in between.

The microscopic description of isolated fungi is presented in Table 3. *Aspergillus flavus* had phialides borne directly on vesticle, conidial heads were radiate later splitting into several loose columns. Conidiophores were hyaline while conidia were globose to subglobose. *Colletotrichum capsici* had single celled falcate conidia with dark brown setae. *Lasiodiplodia theobromae* produced brown conidia which were dark walled and septate. Pycnidia was abundant. *Pythium* sp. had globose sporangia, hyphae dichotomously branched with ovoid oogonia.

Effect of Isolated Fungi on The Infection of Tomato Seedlings

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The effect of isolated fungi on the infection of tomato seedlings is presented in Table 4. *Aspergillus flavus*was highly pathogenic infecting 63.00 % of the tomato seedlings followed by *Lasiodiplodia theobromae*which was moderately pathogenic producing 30.00% infection on seedlings, *Pythium* spp and *C. capsici*were mildly pathogenic producing 17.00% and 12.00% infection respectively on tomato seedlings.

DISCUSSION

The fungi isolated from tomato fruit in this study were *Aspergillus flavus*, *Colletotrichum capsici*, *Pythium* sp. and*Lasiodiplodia theobromae.* Pathogenicity tests also revealed that the isolated fungi were responsible for post harvest deterioration of tomato fruits and seeds in Makurdi and Otukpo Local Government Areas of Benue State, Nigeria.Earlier reports by Fajola (1979) identified *A. flavus, Pythium* sp. and *B. theobromae* as rot pathogens of tomato fruits in Nigeria. Nishikawa *et al*. (2006) also reported *Pythium* sp.on tomato seeds. Akinmusire (2011) reported fungi as the prevalent spoilage organism of some edible fruits and vegetables in Maiduguri, North Eastern Nigeria.*Lasiodiplodiatheobromae* has previously been reported as an important postharvest fungus infecting tropical and sub-tropical fruits and vegetables including tomato (Zhao *et al*., 2015). Furthermore, Zhao *et al*. (2015) observed that. *Lasiodiplodia theobromae* was a post harvest fungus causing soft brown rot on fruits before or after harvest. The fast growth rate of L. *theobromae* in this study agrees with the report Sangeetha *et al*. (2012) in which the fungus filled the 90 mm Petri dish within three to four days of incubation.The presence of fungi in stored tomato fruits is collaborated by previous studies of (Nithiyaa *et al*., 2012) and Zhao *et al.* (2015) in which pathogenic fungi was recorded on fresh, minimally processed fruits and citrus juice respectively.Oyelana *et al*. (2011) and Okigbo *et al*. (2013) also reported L. *theobromae* and *A. flavus* as post harvest rotpathogens on yam while Ekhuemelo *et al*. (2015) reported *C. capsici* and *A. flavus* on pepper fruits.

The presence of these fungi on fresh and stored tomatoes in this study indicate field to store infection. Also dried tomato fruits may have been improperly dried before storageresulting in the colonization of the seed by the various fungi under favourable conditions.The isolated fungi have been reported to be pathogenic to the seeds of different crops causing diseases such as seed rot, damping off, root rot, fruit rot, wilt and foliar diseases (Al-Kassim and Monawar, 2000). Makelo (2010) observed that tomato seed infection resulted in tomato transplants infection by*Clavibacter michiganensis* subsp. *Michiganensis.*Roberts (2003)also noted that Pythiumsp.caused damping off and fruit rot on mature ripe or unripe fruit when in contact with infected soil. The occurrence of *Lasiodiplodia theobromae* on stored fruit in this study may have been infected on the field and continued infection during storage. *Lasiodiplodia theobromae* is reported to survive in the soil and seed for between five and twelve months resulting in reduced seed germination in *Pinus elliottii*(Cilliers *et al*., 1993).

The incidence of *C. capsici*on tomato seeds in this study suggests that the fungus underwent cross infection from pepper to tomato. Nduagu *et al*. (2008) and Rampersad (2011)had earlier reported C. *capsici* as a seed borne fungus of pepper.Planting such infected seeds may either hinder seed germination or transfer the fungus from the seed to seedlings contributing to initial infections on the field. Al-Kassim and Monawar (2000)also reported that seed-borne fungi are known to cause seed rot, decrease seed

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germination, cause pre, post emergence damping off and seedling death.Seed infection also reduces the seed quality, shelf life and marketability of infected crops (Diedhiou et *al*., 2014). Cilliers *et al*. (1993) attributed seed infection by fungi to adverse harvesting and storage conditions.

The predominance of *A. flavus* on tomato fruitsin this study may predispose fresh and dried tomato consumers in the study area to mycotoxin exposure, which may adverselyaffect their health. This is because *A. flavus*is known to producesecondary metabolites and mycotoxins which are carcinogenic and harmful to man (Nithiyaa *et al*., 2012 ; Mensah and Owusu, 2012).

CONCLUSION

Four different fungi were found associated with tomato fruits and seeds in Makurdi andOtukpo LGAs namely*: Pythium sp., Aspergillus flavus*, *Colletotrichum capsici and Lasiodiplodia theobromae.* The presence of these fungi species on tomato fruits in this study indicates the possibility of tomato consumers ingesting these pathogens which may pose a threat to their health and the possibility of seed borne fungi translating to seedling infection when infected seeds are planted. Improved farm sanitation, proper storage and packaging of tomato fruits will ensure the availability of wholesome products for consumers.

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Table 1: Percent occurrence and pathogenicity of fungi isolated from tomato fruits from Makurdi and Otukpo Local Government Areas of Benue State.

Fungi	Plant part	Fungi Occurrence		Percent occurrence (%)	Pathogenicity
		Makurdi	Otukpo		
Aspergillus flavus	Fruit and seed	+	+	26.7	++
Pythium spp	Fruit and seed	+	+	40.0	+++
Colletotrichum capsici	Seed	+	-	6.6	++
Lasiodiplodia theobromae	Seed	-	+	13.3	+

Keys + = Present; - = Absent, Pathogenicity Key + = mild infection (0.5-1cm rot lesion on fruit), ++ = moderate infection (2-3cm rot lesion on fruit), +++ = severe infection (≥5cm rot lesion on fruit)

Table 2: Fungal macroscopic morphological identification

Fungi	Colour and description	Reverse	Growth rate
Aspergillus flavus	Dark green	Green	Fast
Pythium sp.	Aerial white mycelia	White	Fast
Colletotrichum capsici	Light grey with concentric ring of acervuli on mycelium	Light grey in concentric ring	Medium
Lasiodiplodia theobromae	Greyish white and fluffy with abundant aerial mycelium	Greyish to black	Very fast

Table 3: Microscopic description of isolated fungi

Fungi	Microscopic characteristics
Aspergillus flavus	Conidial heads radiate, later splitting into several loose columns, conidia globose to subglobose. Conidiophores hyaline. Phialides borne directly on the vesicle.
Pythium sp.	Sporangia are globose, hyphae dichotomously branched, ovoid oogonia
Colletotrichum capsici	Single celled falcate conidia, dark brown setae.
Lasiodiplodia theobromae	Conidia are brown, non- septate, pycnidia abundant

Table 4: Effect of isolated fungi on the infection and health of tomato seedlings

Fungi	Infected seedling (%)	Healthy seedlings (%)
Aspergillus flavus	63.00	37.00
Pythium spp	17.00	83.00
Colletotrichum capsici	12.00	88.00
Lasiodiplodia theobromae	30.00	70.00
Control (SDW)	0.00	100.00
LSD(0.05)	18.34	18.99

Pathgenicity of *Meloidogyne incognita* on *Brassica oleracea* var. capitata

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Abstract
Pathogenicity studies of Meloidogyne incognita on Brassica oleracea var. capitata commonly known as cabbage was carried out at the screen house of National Horticultural Research Institute, Idi-Ishin, Ibadan from March to May 2017. Four weeks old seedlings were transplanted into sterilized sandy loamy soil in pots. The seedlings in pots were inoculated with 0; 5000; 10000, or 20000 eggs of M. incognita. The trial was laid out in a completely randomized experimental design with four replications. Data were collected on the plant height, leaf number over a period of eight weeks after inoculation, also fresh shoot weight, fresh root weight, galling index, nematode population and reproductive factor were recorded and estimated respectively at the end of experiments. Data analysis at p <0.05 showed significant reduction in fresh shoot and root weight of the inoculated plants. Plants inoculated with 20,000 eggs had the highest root population of root-knot nematode eggs as compared with other inoculum levels. The gall index and reproductive factor in all the inoculation level were greater than 2 and 1 respectively. This showed that the crop was susceptible to M. incognita, these were reflected in the above ground mass in which the uninoculated plants were significantly heavier than inoculated plants. Therefore, nematode management programme is essential to reduce pre plant population in an infested soil as its high potential fecundity will permit population densities to reach an economic threshold and as a results lead to greater damage and loss to cabbage farmers.
Keywords: Meloidogyne incognita, pathogenicity, inoculum, gall index, reproductive factor

INTRODUCTION

Meloidogyne spp. are common in vegetable soils worldwide where they parasitize vascular root tissues and induce root galls. Root-knot nematodes, *M. incognita,* is among the most common (Anwar and McKenry, 2010; Abawi and Widmer, 2000; Davis *et al*., 2003; Sasser, 1979). In addition to extensive root galling leading to malfunction of the root systems, its presence is often associated with increased incidence and severity of *Fusarium* wilts (Anwar and Khan, 1973, Martin et al., 1994). The reduction in yield of vegetable crops due to plant-parasitic nematodes feeding can more than 40% (Anwar and McKenry, 2012), however, this depends on soil texture and prevailing weather conditions (Starr, 1995).

Cabbage (*Brassica oleracea* or *B. oleracea* var. *capitata*, is a member of the genus *Brassica* and the mustard family, *Brassicaceae*. Several other cruciferous vegetables (sometimes known as *cole crops*are susceptible to root-knot nematodes Cabbage is prepared and consumed in many ways. The simplest options include eating the vegetable raw or steaming it. Pests include root-knotnematodes and cabbage maggots, which produce stunted and wilted plants with yellow leaves; aphids, which induce stunted plants with curled and yellow leaves; harlequin bugs, which cause white and yellow leaves; thrips, which lead to leaves with white-bronze spots; striped flea beetles, which riddle leaves with small holes; and caterpillars, which leave behind large, ragged holes in leaves. Therefore, the objective of this research is to establish the pathogenicity of root-knot nematode on *Brassica oleracea* var capitata..

MATERIALS AND METHODS.

The *M. incognita* eggs (inoculum) used were extracted from roots of three- month old *M incognita*-galled *Celosia* using 0.5% sodium hypochlorite method (Hussey and Barker, 1973). The eggs were collected in a 400ml breaker and then thoroughly mixed using magnetic stirrer and the population per ml of the egg suspension was estimated under the stereoscope in a counting dish. The average of five counts

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was taken and diluted to about 1, 000 eggs/ml of suspension. Two seedlings of four week old cabbage were transplanted in a 25- cm- diameter, 11-litre plastic bucket containing steam-sterilized soil. One week after transplanted, the seedlings were thinned down to one uniformly vigorous plant per pot and were inoculated with *M. incognita* eggs at different levels (0, 5,000, 10,000 or 20,000). 0 egg served as control.

The experiment was arranged in a randomized complete block design with four replicates for each treatment. The treatments were four different initial population densities (Pi) of *M. incognita* eggs (0, 5,000, 10,000 and 20,000 eggs). Temperature and relative humidity of the screen house were properly monitored throughout the period of study.

Data Collection

Immediately after inoculation and subsequently at one week intervals, the following data were collected: Plant length, number of leaves. Eight weeks after inoculation the experiment was terminated and the following data were also recorded: fresh shoot weight, fresh root weight, each plant was carefully uprooted and washed to remove adhering soil particles. Galling was quantified using the scale of 0-5. Nematode soil populations from 100ml of soil in each pot and 10g of the roots for eggs population were also estimated.

Statistical Analysis

All data collected were statistically analyzed using the SAS (SAS, 1999) statistical package version 8 and the means were partitioned using the Least Significant Difference (LSD) at a probability level of 5%.

RESULTS

The highest plant height was recorded from uninoculated plants which were not significantly different from plant inoculated with 5000 eggs. The least plant height was recorded from plant inoculated with 20000 eggs which was not statistical different from plants inoculated with 10000 eggs at eight week after inoculation (Table 1).

Eight weeks after inoculation, the highest number of leaves was recorded with plants inoculated with 10000 eggs which were not significantly different from the plants inoculated with 5000 and 0 eggs (Table 2). The highest fresh shoot weight was recorded from uninoculated plants which was significantly different from plant inoculated with 5000, 10000 and 20000 eggs. The least fresh shoot weight was recorded from plant inoculated with 20000 eggs which was statistical different from other treatments ($p \leq 0.05$). Table 3

The uninoculated plants had the lowest fresh root weight and it was not significantly different from other treatments (Table 3). The mean gall indices differed statistically ($P \leq 0.05$) from each other. The plants inoculated with 20000 eggs had the highest mean gall index which did not differ significantly from the values obtained from those inoculated with 10000 and 5000 eggs. The plant without root-knot nematodes eggs had no gall on the roots (Table 3)

The mean total population of *M. incognita* differed significantly ($P \leq 0.05$) from each other. The highest value was obtained from plants inoculated with 20000 eggs which were significantly different from the values recorded from the plants infected with 10000 and 5000 eggs (Table 3). The mean nematode reproductive factor also differed significantly from each other. The highest mean reproductive factor came from the plants inoculated with 20000 eggs and decreased as inoculum densities increased. The lowest significantly value came from uninoculated plants (Table 3).

DISCUSSION

The high reproductive rate of *M. incognita* and degree of root damage exhibited by *M. incognita* on cabbage indicates that cabbage is a good host for this nematode.

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It also demonstrates the pathogenic effect of *M. incognita* and indicates that severe damage could occur if the crop is grown in the field infested with *M. incognita*. The reproductive factor of M. incognita in this study increased with increasing inoculum level from 5,000 to 20,000 eggs per plant. Similar results were reported by Sasanelli et al. (1992); Sasanelli and Di Vito (1992); Di Vito et al. (2000); Zahid et al. (2001); who observed maximum reproductive rates at lower inoculum densities and this increase as the initial population density increased. The information obtained in this study may prove useful in predicting the effect of different inoculum densities on the growth, development and yield of cabbage.

At an inoculum density of 20000 eggs per pot and above (i.e > 2000eggs/ml soil) cabbage growth and development were reduced. The reproductive factor of *M. incognita* in this study increased with increasing inoculum level from 5000 to 20000 eggs per plant. These findings agree with Darekar et al. (1988) on cucumber where, as a result of Meloidogyne infection, complete crop failure occurred.

A nematode management programme is therefore essential to reduce pre plant nematode population in an infested soil as its high potential fecundity will permit population densities to reach an economic threshold and as a results lead to greater damage and loss to cabbage farmers.

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Table 1: The effect of different inoculum levels of Root-knot nematode (M. incognita) on the plant height (PH) for weeks 1-8 of *Brassica oleracea*.

Treatment	PH 1	PH 2	PH 3	PH 4	PH 5	PH 6	PH 7	PH 8
0 Egg	3.75±0.25	4.90±0.26	7.20±0.96	10.25±0.32	19.85±0.76	22.25±1.04	25.00±1.22	25.00±1.22
5000 Eggs	3.00±0.41	4.30±0.11	7.20±0.54	10.63±0.10	17.53±1.91	20.00±1.83	25.30±1.38	23.38±1.46
10000 Eggs	3.25±0.25	4.75±0.32	7.00±0.41	10.26±0.14	14.75±0.25	17.00±0.58	19.50±0.50	19.88±0.47
20000 Eggs	3.00±0.00	3.25±0.48	5.50±1.08	8.50±0.87	11.83±0.99	14.75±0.95	17.50±0.50	19.50±0.00
LSD≤0.05	0.83	0.99	1.23	1.49	3.54	3.65	3.04	3.13

Table 2: Effect of different inoculum levels of Root-knot nematode (*M.incognita*) on number of leaves of *Brassica oleracea*.

Treatment	NL 1	NL 2	NL 3	NL 4	NL 5	NL 6	NL 7	NL 8
0 Egg	4.5±0.50	8.70±0.48	12.00±0.71	17.75±0.85	20.00±0.71	21.00±0.91	21.50±0.64	24.00±0.82
5000 Eggs	4.00±0.00	7.50±0.29	10.50±0.29	16.50±0.87	19.25±0.85	21.50±0.96	24.00±1.41	24.00±1.41
10000 Eggs	3.75±0.23	8.70±0.63	11.75±0.75	17.00±0.82	20.75±0.63	23.00±1.29	24.50±1.25	25.00±1.60
20000 Eggs	3.00±0.41	6.00±1.08	8.25±0.85	12.25±1.03	17.00±1.08	19.50±1.26	19.50±1.94	20.75±1.25
LSD≤0.05	1.07	2.11	2.11	2.76	2.57	3.45	4.29	3.52

Table 3: Effects of *M. incognita* populations on root damage and nematode reproduction of *Brassica oleracea*.

Treatment	Gall Index	Fresh Root weight (g)	Shoot Weight (g)	Eggs in Root (10 g)	J2 in Soil (100 ml)	Total Nematode	RF
0 Egg	0.00±0.00	7.50±0.50	118.00±9.80	0.00±0.00	0.00±0.00	0±0.00	0.00±0.00
5000 Eggs	2.00±0.00	7.50±0.65	105.25±5.31	175.00±18.93	4590±1771.43	4765±1770.32	0.95±0.35
10000 Eggs	2.50±0.29	7.50±0.29	105.00±9.64	552.50±42.70	11160±460.72	11713±494.19	1.17±0.05
20000 Eggs	3.00±0.00	6.25±0.48	87.75±11.54	1250±155.46	25320±2273.34	26570±2136.80	1.33±0.11
LSD≤0.05	0.44	1.52	28.91	250.00	4496.60	4342.44	0.57

Anti Oxidant and anti Microbial Properties of Pineapple Pomace Extract

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Abstract

Waste product generated from Pineapple juice productionwhich constitute varying environmental pollution is now known to be rich in antioxidant. The aim of this study is to investigate the inhibitory properties of pineapple pomace against pineapple die-back disease in vitro. Pineapple pomace was collected after extraction from the juice processing unit of National Horticultural Research Institute, Ibadan. Pomace was dried in a fluidized bed drier at 40°C ±2° for 72hrs. The dried sample was broken into smaller pieces using a mortar and pestle and further reduced using an electric grinder. Phytochemicals and fungitoxicity were evaluated using standard methods. The result showed concentration of total phenol (1.09 mg/g), Flavanoid (0.64 mg/g), tannin (1.04 mg/g), oxalate (1.08 mg/g) and saponin (0.08 mg/g). Pineapple pomace at 10 mg/ml significantly ($p < 0.05$) inhibited the growth of L.theobromaeby 72.2 %. Mycelial growthofother concentrations of pineapple pomace was not significantly ($p < 0.05$) different from each other. Although they were lower than radial growth recorded in the control. A range of between 24 – 41 % mycelial inhibitions was obtained due to lower concentrations of the pomace. This study showed that aqueous extract of pineapple pomace have antifungal activities against L. theobromae and could be a potential formulation for controlling pineapple die-back disease.

Keywords: *Lasiodiplodiatheobromae, pomace, inhibition, pineapple, mycelial growth*

INTRODUCTION

Lasiodiplodiatheobromae is an opportunistic plant pathogen that causes different types of plant diseases with worldwide distribution within tropical and subtropical regions (Faber *et al*., 2007). It is a fungal pathogen of high economic importance to pineapple production in Nigeria.

L. theobromae is a cosmopolitan soil-borne fungus causing both field and storage diseases on a wide host range estimated to be more than 280 plant species, (Domsch*et al*., 2007) although with varied pathological effects on its hosts. This fungus is associated with damping-off, wilt, blight, die-back, root rot, collar rot, stem necrosis, panel necrosis of rubber, gummosis, stump rot, rot of sugarcane, leaf spot, witches' broom, fruit blight, fruit rot, pod rot of cacao, boll rot of cotton, seed rot, storage rot of cassava, sweet potato and yams etc.(Punithalingam, 1980).

Pineapple (*Ananascomosus* (L.) Merr.), a member of the family Bromeliaceae which encompasses about 50 genera and 2000 species mostly epiphytic (Batholomew and Maleieux, 1994). It is cultivated predominantly for its fruits that is consumed fresh or as canned fruit and juice. The worldwide total pineapple production is between 16 to 19 million tons (FAO, 2009). The fruit juice is the third most preferred worldwide after orange and apple juices (Cabrera *et al.,* 2000). It dominates the world trade of tropical fruits, accounting for 51% of world global fruit market (FAO, 2009) and gains popularity in Nigeria due to fruit juice importation ban. The vast use of pineapple has encouraged its large industrial production and has made its waste product constitute varying environmental pollution. Fruit residues may cause serious environmental problems, since it accumulates in agro-industrial yards without having any significant and commercial value. Disposal of these wastes is expensive due to high costs of transportation and a limited availability of landfills, they are unscrupulously disposed hence, causing environmental problems.Furthermore, the problem of disposing these by-products is further aggravated by legal restrictionshence the need to find beneficial use of it. The objective of this study was to investigate the inhibitory properties of pineapple pomace extract against *L.theobromae in vitro.*

MATERIALS AND METHODS

Collection and preparation of sample

Pineapple pomace was collected after extraction from the juice processing unit of National Horticultural Research Institute, Ibadan. Pomace was dried in a fluidized bed drier at 65^oC ±2^o for 72hrs. The dried sample was first reducedinto smaller pieces using a mortar and pestle and further milledinto powder using an electric grinder. The powder was stored in an air tight bottle and refrigerated until needed.

Preparation of extract

Ten grams sample was weighed into a sterilized conical flask containing 100ml methanol and left for 24 hrs. The mixture was stirred at interval using a sterile rod and filtered through a Whatman No. 1 filter paper. The filtrate was evaporated to dryness under reduced pressure at 50^0C using rotary evaporator. The extract was stored in a sterilized bottle and kept in a refrigerator at 4^oC until use. Extract yield was calculated using the method of (Enikuomehin and Oyedeji, 2008).

$W_S = W_1 - (W_2 + W_3$

Where W_S = weight of dissolved sample

W_1 = initial weight of sample before extraction

W_2 = weight of oven dried sample

W_3 = weight of filter paper.

Phytochemicals screening and analysis of pomace

Extracts of pineapple pomace were screened andanalyzed for total phenol and flavonoid as described by Jung *et al*.,(2008), oxalate, phytate and saponin according to method of Ijarotimi*et al*., (2013)

Antifungal evaluation of pineapple pomace

Antimicrobial activity of pineapple pomace was evaluated against *Lasiodiplodiatheobromae*using poisoned food techniques. Potato Dextrose Agar was poisoned with 1ml extract of pineapple pomace extract. Extract and the medium was allowed to solidify and 3 mm mycelia disc obtained from the edge of 7 day old culture of *L. theobromae*ewas placed at the center of the petri dish. Inoculated plates without extract served as the control. Plates were incubated at 28^oC ± 2^0C for 7 days. Radial growth was measured daily as the mean growth along the two axes on two pre-drawn perpendicular lines on the reverse side of the plate.Fungi toxicity was expressed as percentage inhibition of mycelia growth using formula adopted from Awuah, (1989);

$$M_P = \frac{M_1 - M_2}{M_1} X\ 100$$

Where M_P = percentage inhibition of mycelia growth

M_1 = mycelial growth in control plate

M_2 = mycelial growth in plate containing plant extracts.

RESULTS AND DISCUSSION

The result of phytochemical screening showed the presence of flavonoid, tannin, saponin and absence of alkaloids (Table 1). Phenolic compound are secondary metabolites and are of considerable physiological and morphological importance in plant. These compounds played an important role in plant growth and reproduction, also in providing protection against pathogens and predators (Balasundram*et al*., 2006). Total phenol being the most widely occurring group in plant was found to be 1.09 mg/g, followed by oxalate (1.08 mg/g), tannin (1.04 mg/g), flavonoids (0.64 mg/g) and saponin (0.08 mg/g) (Table 1). The presence of these phytochemicals suggested their crucial role in plant development and in their interaction with their biotic and abiotic environment (Kim *et al*., 2004). Cold water extract of pineapple pomace evaluated in this study showed inhibitory potential against

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Lasiodiplodiatheobromae. At 10 mg/ml pineapple pomace concentration, radial growth of *L.theobromae*wassignificantly P ≤ 0.05 reduced (24.2 mm) in comparison with other concentrations. (Table 2). However, mycelial growth due to lower concentrations of pineapple pomace were not significantly different but lower than growth recorded for the control. While the highest mycelial growth inhibition (72.2%) was recorded at 10 mg/ml concentration, a range of between 51.3 – 66.0 % were recorded at lower concentrations (Table 2). Studies have shown fungitoxicity potentials of various plant extracts in the management of *L. theobromae for example*extracts of *Ocimumgratissimum* and *Aframomummelegueta* leaves have been shown to inhibit the growth of *L. theobromae* mycelium, the causative agent of banana anthracnose (Okigbo and Ogbonnaya, 2006),also extracts from the leaves of *Caricapapaya*, *Chromolaenaodorata* and *Acalyphaciliata* have been reported to inhibit the growth of *L. theobromae* causing pawpaw fruit rot fungi (Ilondu, 2011 and Nweke, 2015).One or two more references may be cited to buttress your facts here.) Inhibitory potentials of pomace may be attributed to the presence of phytochemicals such as tanins and saponins. Tanins have been reported to possess antibacterial properties which act by different mechanisms, including enzyme inhibition (Parekh and Chanda 2007). Saponins have also been found to demonstrate antimicrobial properties particularly against fungi, bacterial and protozoa (Debella*et al*., 1999) and also serve as anti feedants and protect plants against microbes and fungi (Weintraab, 1993).

CONCLUSION

The study showed that aqueous extract of pineapple pomace have antifungal activities against *L. theobromae*. This suggests its potential for future formulation into products for controlling pineapple die-back disease. However, further studies should be conducted on the efficacies of the extract *in vivo*.

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Table 1: phytochemical screening and quantification of pineapple pomace

Phytochemical	Screening	Concentration (mg/g)
Total phenol	ND	1.69
Flavonoid	+	0.64
Tannin	+	1.04
Oxalate	ND	1.08
Phytate	ND	0.37
Saponin	+	0.08
Alkaloids	-	NA

\+ = Presence, = Absent, ND = Not determined, NA = Not applicable

Table 2: Effect of pineapple pomace extract on radial mycelial growth of *Botrydiplodia theobromae*after 7 days incubation at 28±2ºC.

Concentration (mg/ml)	Radial growth (mm)	% inhibition
0	87.00a	0.00
2	66.00b	24.14
4	62.17b	28.54
6	57.67b	33.71
8	51.33b	41.00
10	24.17c	72.22
LSD 0.05	6.80	-

Values are obtained from mean of 4 replicate plates of fungal pathogen per treatment. Means with the same alphabet in the same column are not significantly different (P≤0.05) Duncan's Multiple Range Test.

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Changes in Seed Quality Characters of Fluted Pumpkin (*Telfairia Occidentalis*) during Storage under Ambient Humid Condition

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Abstract
This study was carried out to investigate the changes in seed quality parameters of fluted pumpkin (Telfairia occidentalis) stored under ambient condition at the laboratory of Department of Plant Breeding and Seed Technology, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. Three morphotypes (NHTor-101, NHTol-102, and NHToc-103) were utilized for the study in a completely randomized design with three replications. The fruits were de-pulped and the seed extracted and cleaned with saw dust. The seeds were kept under ambient conditions (27 - 30°C) in open basket for 9 days in order to monitor the time of loss of seed viability and vigour. The seeds were sampled and evaluated at 0, 3, 6 and 9 days after extraction (DAE). Data collected on seed moisture content, 100-seed weight and seed physiological characters were subjected to analysis of variance and significant treatment means were separated using Tukey's HSD test at 5% probability level. The results revealed considerable differences among the three morphotypes for seed physiological parameters evaluated. Seeds of NHTol-102 had the highest moisture content and 100 seed weight. Highest seedling emergence (100%), seedling length (18.26 cm), number of leaves and seedling vigour index were observed in NHTor-101. Seeds evaluated at 0 DAE had the highest moisture content and 100 seed weight while at 3 DAE highest physiological characters were recorded. Seeds evaluated at 9 DAE exhibited the lowest 100 seed weight, seedling emergence, seedling vigour index among other parameters. It is therefore recommended that storage period for extracted Telfairia occidentalis seed should not be more than 3 days in order to achieve high germinability and good growth.
Keywords: *Recalcitrance, Seed moisture, Seed storage, Seedling emergence, Telfairia*

INTRODUCTION

Telfaria occidentalis Hook, commonly called fluted pumpkin, is grown mainly for the leaves, which constitute an important component of the diet in many West African countries (Gill, 1988). The leaf is of high nutritional, medicinal and industrial values rich in protein, fat, minerals and vitamins (Akanbi *et al*., 2007). The protein contents of seeds and leaves are 20.5g and 2.9g respectively (FAO, 1988; Schipper 2000). The level of iron is the reason for its use in the leave extraction of blood tonic which can be administered to weak patients (Akoroda, 1990).

However, there is limited identifiable information on the crop in terms of varieties, preservation, storage methods, oil composition among others. The plant is fairly drought-tolerant, dioecious perennial that is usually grown trellised. (Odiaka and Schippers, 2004) Seeds of *Telfairia occidentalis* are recalcitrant or intolerant of desiccation. Consequently, seed stock for the next planting season is maintained locally by storing fully matured fruits (Nkang *et al*., 2000). Due to their high moisture contents, they can only be maintained in short term storage (about 3 months) as seeds held in pods usually rot or progress directly to germination. Although, pumpkin seeds are recalcitrant, limited desiccation enhances their germination (Nkang *et al*., 2000). Since they are highly susceptible to desiccation injury they must maintain relatively high moisture content in other to remain viable. According to Dayan (1997) critical moisture content

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is generally 12-40% for *Anisoptera thurifera* seed but according to Dickie and Pritchard (2002) it is within the ranges 25-40%. Recalcitrant seeds do not undergo maturation drying and are therefore shed at high water content.

Poor storability of seed leading to scarcity at planting period is a major problem of *Telfairia* seed production. Moreover, little information exists on the effects of moisture loss on viability and vigour in *Telfairia* after fruits maturation. Similarly, there is dearth of information on critical seed moisture content for *Telfairia*. It will therefore be necessary to determine at what stage after the seed removal/extraction from the fruit will give highest physiological quality as well as the critical seed moisture for optimum germination. The objective of this study was to determine how long *Telfairia occidentalis* seed will remain viable after depulping or extraction from fruit/pod and the critical seed moisture.

MATERIALS AND METHOD

Fruits of three morphotypes (NHTor-101, NHTol-102 and NHToc-103) of *Telfairia occidentalis* were collected from National Horticultural Research institute (NIHORT), Ibadan in February 2012. The fruits were harvested three months before the commencement of the study. The seeds were extracted by de-pulping the fruits. Seeds were further rubbed with dry saw dust to remove mucilaginous covering and pulp remnants. The seeds after cleaning were kept in open basket for assessment in the laboratory of the Department of Plant Breeding and Seed Technology, Federal University of Agriculture, Abeokuta, Ogun State Nigeria. Ambient temperature ranged between 27-30°C as RH was 55 – 66 %. The seeds were stored for 9 days and evaluated at 0, 3, 6 and 9 DAE to determine time of loss of seed viability and vigour parameters. The experiment was a factorial in a completely randomize design with three replicates. Data collected were -

a. 100-seed weight: One hundred seeds in three replications were counted from each morphotype and weighed at each sampling period.

b. Seed moisture content: 25g of seeds from each treatment were oven dried at 105°C for 17 hours following ISTA (1985) procedure.

c. Seedling emergence: this was done by counting 25 seeds in three replicates from each treatment. The seeds were sown in nursery plastic bowls filled with moistened sawdust and monitored for 18 days. Seedling emergence (%) was calculated as - Number of emerged seedlings after 15 days /Total number of seed sown x 100

The following traits were also assessed:

i. Seedling length was determined by measuring the shoot length of five seedlings randomly with a meter rule at 18 DAS

ii. Number of leaves of five seedlings was counted at 18 DAS

iii. Seedling vigour index (SVI) was determined using the procedures of Kim *et al.* (2002). It was calculated as

SVI = Seedling Emergence (%) x seedling length/100

Data collected were subjected to analysis of variance (ANOVA) and significant treatment means were separated using Tukey's HSD at 5% probability level.

RESULTS

Data in Table 1 shows the analysis of variance (ANOVA) of seed quality parameters evaluated in three fluted pumpkin morphotypes. The result showed that morphotype, storage time and their interaction had highly significant (P $\leq$ 0.01) effect on all the evaluated parameters.

The result in Table 2 revealed that highest moisture content was obtained in NHToc-102 with 33.58%, followed by NHToc-103 (31.11%) while NHTor-101 had the lowest moisture content of 28.99%. Also, NHToc-102 had the highest 100 seed weight (1110.51g) as NHTor-101 had significantly lowest value of 1005.43g. In contrast, seedling emergence was significant and higher in NHTor-101 with 78% while the other two morphotypes exhibited similar and lower seedling emergence. Seedling length was highest in NHTor-101 (18.26 cm) while NHToc-103 had the shortest (11.46 cm). The number of leaves and seedling vigour index were also highest in NHTor-101 while NHToc-103 recorded the lowest. The effect of storage time indicated that the highest seed moisture content and 100 seed weight were recorded at 0 day after extraction (DAE) with 40.04% and 1238.53g respectively (Table 2). The values decline steadily to 21.42% and 915.69g at 9 DAE. Seedling emergence, number of leaves and seedling vigour index were however, highest at 3 DAE with 100%, 6.25 and 17.28 respectively while the lowest values were obtained at 9 DAE. With respect to seedling length, highest value was recorded at 6 DAE (18.64 cm) but this was not significantly different from values obtained at 0 and 3 DAE (14.43 and 17.28 cm respectively).

Furthermore, the interaction of morphotype and storage time revealed that seed moisture content and 100 seed weight were highest in the three morphotypes at 0 DAE and decreased generally with increase in storage time till 9 DAE.

A cursory look at table 4 revealed that seedling emergence was similar, significant and highest in NHTor-101 at both 0 and 3 DAE (100 %) followed by 75% emergence at 6 DAE. The lowest seedling emergence was recorded at 9 DAE with 37 %. In NHTol-102, seedling emergence varied significantly from 100 % at 3 DAE to 33.33% at 9 DAE. Similarly, seedling emergence in NHToc-103 was significantly highest at 3 DAE (100 %) while at 9 DAE the lowest value of 23.90% was obtained. Still on table 4, seedling vigour in NHTor-101 ranged from 23.70 at 0 DAE to 3.82 at 9 DAE. Highest seedling vigour was observed in NHTol-102 at 6 DAE with 17.57 whereas 4.10 was recorded at 9 DAE which is the lowest. NHToc-103 recorded highest seedling vigour at 3 DAE (16.46) while the lowest was at 9DAE.

The result in table 5 revealed that seedling length in NHTor-101 at 0 DAE was not significantly different from 9 DAE with 23.70 cm and 22.50 cm respectively. However, seedling length was lowest at 9 DAE with 10.33 cm. In contrast, seedling length was 23.43 cm in NHTol-102 which is significantly different from the other three storage time. Seedling at 0, 3 and 9 DAE were not significantly different from one another. NHToc-103 recorded highest seedling length at 3 DAE but not significantly different from seedling length at 6 DAE. Lowest value was recorded at 9 DAE. The number of leaves followed the same trend observed in seedling length for the three morphotypes at each storage time.

DISSCUSION AND CONCLUSION

The variations observed among the three fluted pumpkin morphotypes in terms of

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the seed quality parameters shows that they are genetically diversed. Variations in storage behavior among crop species have been documented by different authors (Adebisi *et al* 2012, Abdul-Rafiu, 2015). High moisture content observed in NHTol-102 may be partly responsible for high 100 seed weight. Reduced seed moisture in NHTor-101 may likely be responsible for higher seedling emergence, vigour and growth as Nkang *et al*, (2000) have previously reported that limited desiccation enhances seed germination in Tefairia despite the fact that the seed is recalcitrant. Freshly extracted seeds had the highest moisture and this may also be partly responsible for the highest 100 seed weight observed. However, seedling, emergence, vigour index and other parameters at 0 DAE were less when compared to seeds evaluated at 3 DAE. Moreover, at 3DAE the seeds had lost 23.60% moisture while 100 seed weight was already reduced by 11.55% but with this reduction highest seedling emergence, vigour, length and number of leaves were recorded. This implies that these changes (loss of moisture through passive drying) enhanced physiological quality of *Telfairia* seed. The study also indicated critical seed moisture for maximum physiological quality (seedling emergence, vigour index among others) to range between 31 and 36.65 % and this occurred at 3 DAE. Although, an increase/decrease of 6% critical range still gave about 75% seedling emergence. It can be inferred that reducing the moisture content below this range may lead to degeneration of active and living part of the seed. Previously, Akoroda (1986), Nkang *et al*, (2003) among other researchers have classified the seeds of *Telfairia* as recalcitrant but the minimum seed moisture for the seed to retain its viability was not quantified. Therefore, storing the seed after extraction and cleaning for not more than three days in open basket under shade is similar to curing and could enhance the physiological quality for sowing purposes. Also, seed moisture content for *Telfairia* ready for sowing should not be less than 31% as this may result in degenerative changes in seed quality resulting in low germination.

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Table 1. Analysis of variance showing the mean square values for seed quality characters evaluated in three morphotypes of fluted pumpkin (*Telfairia Occidentalis*)

Source of variation	D.F	Moisture content (%)	100 seed weight (g)	Seedlings emergence (%)	Seedling length (mm)	Number of leaves/plant	Seed vigour index
Replication	2	0.01	1767.77	67.42	68.69	88.86	7.66
Morphotype (M)	2	74.28**	38001.98**	668.47**	922.41**	223.03**	680.83**
Storage time (S)	3	238.66**	82403.63**	9525.06**	730.75**	118.04**	1153.50**
M x S	6	7.83**	40093.44**	869.85**	265.05**	95.95**	292.93**
Error	22	0.05	2016.30	154.92	71.94	26.62	42.56

**significant at 1% level of probability
*significant at 5% level of probability

Table 2. Main effect of morphotypes and storage time on seed moisture, weight and physiological characters in fluted pumpkin (*Telfairia Occidentalis*)

Morphotype	Seed Moisture content (%)	100 - seed weight (%)	Seedling emergence (%)	Seedling length (cm)	Number of leaves	Seedling vigour index
NHTor-101	28.99[c]	1005.43[c]	78.00[a]	18.26[a]	6.25[a]	14.24[a]
NHTol-102	33.58[a]	1110.51[a]	64.58[b]	15.11[b]	6.16[a]	9.76[b]
NHToc-103	31.11[b]	1066.71[b]	65.53[b]	11.46[c]	4.31[b]	7.51[b]
Storage Time (DAE)						
0	40.04[a]	1238.53[a]	79.17[b]	14.43[a]	5.26[a]	11.35[b]
3	34.13[b]	1095.49[b]	100.00[a]	17.28[a]	6.25[a]	17.28[a]
6	29.32[c]	993.82[c]	75.00[b]	18.64[a]	6.11[a]	13.98[b]

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9	21.42^{d}	915.69^{d}	23.44^{c}	9.51^{b}	4.67^{b}	2.22^{c}

Means followed by the same alphabet along the column are not different from another according to Turkey HSD at 5% probability level.

Table 3. Effect of storage time after depulping on seed moisture content and 100 seed weight in three morphotypes of fluted pumpkin

Storage Time	Moisture content (%)			100 seed weight (g)		
(DAE)	NHTor-101	NHTol-102	NHToc-103	NHTor-101	NHTol-102	NHToc-103
0	35.55^{a}	45.55^{a}	39.01^{a}	1120.12^{a}	1350.17^{a}	1245.31^{a}
3	31.71^{b}	36.65^{b}	34.03^{b}	1060.77^{b}	1120.73^{b}	1104.97^{b}
6	28.35^{c}	30.05^{c}	29.55^{c}	960.00^{c}	1025.67^{c}	995.79^{c}
9	20.35^{d}	22.06^{d}	21.85^{d}	880.83^{d}	945.47^{d}	920.77^{d}
Mean	28.99	33.57	31.11	1005.43	1110.51	1066.71

Means followed by the same alphabet along the column are not different from another according to Turkey HSD at 5% probability level.

Table 4. Effect of storage time after depulping on seedling emergence and seedling vigour index in three morphotypes of fluted pumpkin.

Storage	Seedling Emergence (%)			Seedling vigour index		
Time(DAE)	NHTor-101	NHTol-102	NHToc-103	NHTor-101	NHTol-102	NHToc-103
0	100.00^{a}	50.00^{c}	77.50^{b}	23.70^{a}	5.89^{c}	5.81^{c}
3	100.00^{a}	100.00^{a}	100.00^{a}	22.50^{a}	12.88^{b}	16.46^{a}
6	75.00^{b}	75.00^{b}	75.00^{b}	12.37^{b}	17.57^{a}	12.00^{b}
9	37.00^{c}	33.33^{d}	23.90^{c}	3.82^{c}	4.10^{c}	2.28^{d}
Mean	78.00	64.58	72.01	14.24	9.75	7.33

Mean followed by the same alphabet along the column are not different from another according to Turkey HSD test at 5% probability level.

Table 5. Effect of storage time after seed extraction on seedling length and seedling vigour index of three morphotypes of fluted pumpkin.

Storage	Seedling length (cm)			Number of leaves		
time (DAE)	NHTor-101	NHTol-102	NHToc-103	NHTor-101	NHTol-102	NHToc-103
0	23.70^{a}	11.78^{b}	7.50^{b}	7.33^{a}	5.33^{b}	3.13^{b}
3	22.50^{a}	12.88^{b}	16.46^{a}	7.00^{a}	5.67^{b}	6.07^{a}
6	16.50^{b}	23.43^{a}	16.00^{a}	5.00^{b}	8.33^{a}	5.00^{a}
9	10.33^{d}	12.33^{b}	5.88^{b}	5.67^{b}	5.33^{b}	3.02^{b}
Mean	36.51	27.11	20.46	18.00	18.42	12.23

Mean followed by the same alphabet along the column are not different from another according to the Turkey HSD test at 5% probability level.

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Host Preference of *Bactrocera dorsalis* (Hendel) (Diptera: Tephritidae) for Various Fruits in Ibadan South-Western Nigeria.

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Abstract
An Experiment was conducted in the laboratory to determine the oviposition preference of Bactrocera dorsalison six host fruits: Avacado (Persia Americana), Mango (Mangiferaindica), Bush mango(Irvingiagabonensis), Guava (Psidiumguajava), Sweet orange (Citrus sinensis) and banana(Musa spp) under free and no choice conditions. In the free choice condition, the six hostsplaced collectively into rearing cages and exposed to the flies for 24 hours, while in the no choice condition, five hundred grammes (500 g) of each fruit was placed separately into different rearing cagesinto which the adult fruit flies had already been placed.In both conditions, the flies were suplpliedwith artificial diet and water.Results showed that bush mango was preferred both in free choice and no choice test conducted. In free choice test a significantly higher pupal population (380.16), pupal weight (13.25mg) as well as percentage adult emergence (92.06 %) was observed in bush mango, while pupal population (248.76), pupal weight (22.57 mg) and 94.3 % adult emergence was recorded in the no choice test in relative to other fruits offered to the flies. The order of preference of the flies to the host presented in the study was Irvingia> mango > banana > guava > avocado > Citrus.
Key words: Fruit fly, Bactrocera dorsalis, host preference, oviposition.

INTRODUCTION

Fruits and vegetables play a very important role in human nutrition and health (Nagy and Shaw, 1980). They also contribute immensely to job creation and income generation of both the rural and urban dwellers (Gardner and Halweil, 2000). Worldwide production of fruits and vegetables has risen at an impressive rate of 4.97% annually (FAO, 2004). In Nigeria, fruit and vegetable consumption is on the increase owing to greater appreciation of their food valueand importance to health (Haruna, 2003).

Despite the efforts of increasing the production and consumption of fruits and vegetables, the sector is faced with diverse setbacks of which insect pests are paramount. Different insect pests infest fruits and vegetables in Africa but one of the major damages is caused by fruit flies (Diptera: Tephritidae).

The genus Bactrocera is considered a serious threat of horticultural crops because of the wide host range of its species and the invasive power of some species within the genus (Clarke et al., 2005).

Bactrocera dorsalis (Hendel) (Diptera: Tephritidae) has been established to be the most dangerous and widespread fruit fly species in Nigeria (Umeh *et al*., 2004).It is a polyphagous and persistent pest of fruits and vegetables causing direct and indirect economic damage effecting yield and reducing the value and marketability of horticultural crops (Sarwar, 2006). Losses ranging from 40 -70 % have been observed in the country due to the attack of this pest (Umeh*et al*., 2004) and this has contributed to the problem of food security in Nigeria.The greatest damage being the rejection of the commoditiesdue to the presence of the maggots on fruits, making them unfit for human consumption (Stonehouse et al., 2002; *Umeh et al*., 2004).

Infestation of insects on fruits is based on preference and this has been reported for many insect species including fruit fly.

Host-performance in herbivorous insects has been demonstrated in numerous studies; however,this behavior is

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connected with the insect's specificity to determine the host plants, changes in host and insect-plant co-evolution (Thompson and Pellmyr, 1991).Fitt (1986) reported that the abundance of species on different hosts was due to more the choices made by females than to larval specialization.Female adult fruit flies determine into which fruit to oviposit based on the suitability of the fruit for their offspring's performance (Joachim-Bravo et al., 2001; Fontellas-Brandalha and Zucoloto, 2004).Fruit flies can respond differently to the host plants and the hosts that are of advantageous to the pests may be more adapted (Sarwar, *et* al., 2013). Host choice and preference of the fruit flies have impacts on growth and development as well as quality of horticultural crops.This study was designed to evaluate host preference of fruit flies to different fruit hosts under laboratory conditions.

MATERIALS AND METHODS

This study was conducted in the insectary of the National Horticultural Research Institute (NIHORT) Ibadan, Nigeria.The insectary was maintained at temperature 25 - 27^{0} C and relative humidity 75 – 80 % under natural lighting condition. The experiments consisted of six different treatments (which are the fruit hosts) and each replicated thrice. The six hosts used for the experiments included Avacado (*Persea Americana*), Mango (*Mangiferaindica*), Bush mango (*Irvingiagabonensis*), Guava (*Psidiumguajava*), Sweet orange (*Citrus sinensis*) and Banana (*Musa acuminata*). Mango, sweet orange, guava was collected from the Institute's orchards while banana, avacado and bush mangowere purchased from a local fruit market.

The experiment was conducted in two phases, free choice test and no choice test.

Free choice test:

At the onset of the experiment, the cages were cleaned and two hundred (200) pairs of fruit flies from the stock culture already maintained in the insectary were sexed and released into thecages measuring (45 cmx 45 cm x 50 cm).The six fruit hosts were then collected, washed, dried and placed collectivelyinto the cages and exposed to the flies for 24 hours. These hosts were provided as mating sites and egg laying spots for the female flies. Artificial diet of mixture of sugar and powdered soybeans in ratio (3:1) was placed in a petri dish and supplied as food while water was put in a container with cotton swab for easy uptake of water by the flies. The artificial diet was used in place hydrolyzed yeast because of its availability and it is economical.After 24 hours, theinfested fruits were removed for incubation. They were placed separately into plastic bowls (7cm diameter) containing artificial diet (mixture of powder soyabeans, wheat, sugar and water in ratio 2:4:4:1) prepared for the larvae. The bowls were later placed in bigger transparent bowls containing sterilized sand (for pupation) with wire gauze and later covered with white muslin cloth and fastened at the edge of the bowl with a rubber-band to prevent escape of the larvae. The larvae, which developed in the fruits, developedinto pupate in the sand. Puparia were collected and the number of puparia that emerged from each fruit were counted. Observations were recorded on pupal weight and adult emergencefor each fruit.

No choice test:

Five hundred grammes (500 g) of each fruit was placed separately into different rearing cages measuring (45 cmx 45 cm x 50 cm) into which 50 pairs of adult fruit flies had already been placed and supplied with artificial diet with water. The procedure for inoculation, pupariacount as well as data collection was done as explained in the free choice test.

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Collected data from the two tests were subjected to analysis of variance (ANOVA), significant means were separated using Least Significant Differences (LSD) at P= 0.05 probability level.

RESULTS:

The type of fruit *B.dorsalis* was exposedto significantly influenced their behavior in terms of oviposition, pupal number, pupal weightand adult emergence. Table 1 showed host preference of *B. dorsalis* when exposed to different natural fruit hosts under free choice condition. The result revealed that *B. dorsalis* preferred laying its egg in bush mango (*Irvingia*) which produced significantly higher pupal population (380.16) and this was closely followed by mango (*Mangiferaindica*) (292.05) and then banana (201.33), while the least pupal population was recorded in citrus (18.05). Similarly, pupal weight was significantly higher in bush mango (*Irvingia*) (13.25mg) when compared to other fruits used for the experiment.Not all the pupae collected eventually emerged into adults.Percentage adult emergence was observed to be maximum in bush mango (92.06) and least in Avocado (44.03).

Table 2 shows the result of feeding preference of *B.dorsalis* under no choice condition. The result showed that bush mango gave significantly higher pupal recovery (248.76 pupal/ fruit)), this was followed by mango (145.33 pupal/fruit) and banana (102.15 pupal/ fruit) which also showed highly significant result as compared to others. Pupal weight generally varied significantly depending on the host fruit used. Pupal weight was maximum in bush mango (22.57mg) and least in avocado (2.35mg). Adult emergence was significantly higher in bush mango(94.27%) and least in avocado (52.18%).

DISCUSSION:

The preference of *B. dorsalis* to six host fruits was carried out in the laboratory. Preference of *B. dorsalis*tothe hosts used was significant(P = 0.05). *B. dorsalis* prefers *Irvingia,* then mango and banana as compared to other fruits used in the experiment in the order Irvingia> mango > banana > guava > avocado > Citrus.

This implies that all the six fruit hosts can be used by *B. dorsalis*for oviposition depending upon their availability. The higher biological activities recorded in Irvingiain this study corroborates the findings by Fontellas-Brandalha and Zucoloto(2004), that oviposition in fruitflies depends upon the flies' decision to select the proper host which must support the activities of their offsprings. It is also similar to the findings of others such as Akol*et al*. (2013) that female insects prefer to oviposit on hosts in which their offspring fare best andFitt(1986) that the abundance of species on different hosts was due to choice made by females than to larval specialization. The factors responsible for these preferences of hosts have been shown by others to include the quality of the hostfor progeny development of fruit fly species,fruit odour, size and colour(Li-Li *et al*., 2008; Wisotsky*et al*., 2011).Drew *et al*., (2003),Brevault and Quilici, (2007) and Mahfuza*et al*., (2011) reported that the female fruit fly's response to assess larval hosts is influenced by using olfactory, visual and contact cues.

CONCLUSION:

The investigation established the fact that Irvingia is the most preferable fruit for oviposition by the fruit fly *Bactrocera dorsalis* as evidenced by performance parameters, showing the highest number of pupae, pupa weight, adults' emergence and percent emergence of adult flies. Mango and banana were the nextattractive hosts when offered as free choice and no choicerespectively;however, least

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preference was sweet orange with consequently the least infestation.

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Table 1: Preference of *Bactrocera dorsalis* to different fruit hosts under Free Choice condition

Hosts	Pupal/ fruit	Pupal wt (mg)	Emerged adult	% emergence
Avocado	20.85	4.15	9.18	44.03
Mango	292.05	10.27	259.57	88.87
Bush mango	386.16	13.25	355.38	92.06
Guava	120.53	5.45	98.64	75.18
Orange	18.46	5.32	9.35	45.23
Banana	201.33	7.15	165.75	80.84
LSD	14.57	0.12	13.25	3.15

Table 2: Preference of *Bactrocera dorsalis* to different fruit hosts under No Choice condition

Hosts	Pupal/ fruit	Pupal wt (mg)	Emerged adult	% emergence
Avocado	25.2	2.35	13.15	52.18
Mango	145.33	8.15	128.25	88.24
Bush mango	248.76	22.57	234.52	94.27
Guava	85.42	4.95	74.28	86.96
Orange	32.85	5.75	17.96	54.67
Banana	102.15	6.48	89.25	87.4
LSD	11.26	0.1	9.84	2.75

Variable Inhibitory Activity of Some Botanicals on the Mycelial Growth of *Sclerotium rolfsii*sacc. Causal agent of Southern Blight Disease of Tomato (*Lycopersicon esculentum* Mill.)

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Abstract
Laboratory experiment was conducted in the Pathology laboratory of theNational Horticultural Research Institute (NIHORT), Ibadan to determine the antifungal effect of some plant extracts at different concentrations to control Sclerotium rolfsiiin vitro. The aqueous and ethanolic extracts ofChromolaena odorata, Tetrapleura tetraptera and Vernonia armygdalina each with threeconcentrations (5, 10 and 15% (w/v) were evaluated against Sclerotium rolfsii with synthetic fungicide (Mancozeb 2.5g/l) impregnated plates and untreated plates served as checks. The experiment was arranged in a Completely Randomized Design (CRD) in three replications. The results showed a promising antifungal activity of both the aqueous and ethanolic extracts of these plants against S.rolfsii. The antifungal activity ranges from 42.6 - 65.3% in aqueous extracts and 41.8 - 64% in ethanol extracts. Among the three plant extractsboth aqueous and ethanolic extracts of C. odorata at 15% gave the highest (65.3 and 64% respectively) mycelial reduction (P< 0.05) and these are comparable to 65% obtained from plates impregnated with synthetic chemical (Mancozeb) while the untreated plates had 100% mycelial growth. These results showed that the selected plant materials could be promising antifungal agents in the Integrated disease management of Sclerotium rolfsii.
Key words: *Antifungal, Sclerotium rolfsii, Southern blight, mycelial growth reduction, in vitro*

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill), is one of the most popular vegetable crops in the world and is attacked by a large number of fungal pathogens. Southern blight (caused by *Sclerotium rolfsii* Sacc.) is one of the most devastating diseases affecting tomato especially in tropical and subtropical regions with substantial yield losses. (Banyal *et al*., 2015). The pathogen attacks the collar portion of plant, which ultimately leads to its death. The infection leads to the drying of lower leaves and eventually the whole plant dries giving a typical symptom of wilting. Southern blight is difficult to control because the fungus has a broad host range that includes over 500 plant species, and sclerotia can survive for several years in soil.Various control measures ranging from the use of chemicals, biological agents, soil amendments, cultural modifications, disease physiology, nutrition studies, and cultivar/variety resistance (Singh and Dwivedi, 1991) have been employed however, all these efforts has not yielded maximum results due to high cost of fungicides, health risk on humans and effects on the environment. The search for natural products with novel uses, particularly related to Southern blight management is a very important task.The use of plant extracts has been shown to be eco-friendly and effective against many plant pathogens (Khallil, 2001, Gachomo and Kotchoni, 2008, Latha *et al.*, 2009, Moslem and El-Kholie, 2009, Duru and Onyedineke, 2010). Plants have ability to synthesize aromatic secondary metabolites, like phenols, phenolic acids, quinones, flavones, flavonoids, flavonols, tannins and coumarins (Cowan, 1991). These groups of compounds show antimicrobial effects and serve as plant defense mechanisms against pathogenic microorganisms (Das *et al*., 2010).. Therefore, the aim of this work isto search for easily accessible, environmentally friendly, cost effective alternative plant productsthat could become an integral part of the integrated pest management for southern blight of tomato.

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MATERIALS AND METHODS

Isolation and identification of Pathogen

Isolation of *S. rolfsii*was done using the direct plating method.Infected tomato stem were washed thoroughly in sterilized distilled water, cut into small pieces with a sterile scalpel, surface-sterilized in 5% sodium hypochlorite, rinsed in three changes of sterile distilled water, air-dried on sterile filter paper and plated on Petri-dishes containing Potato Dextrose Agar (PDA) amended with (60mg/ml) chloramphenicol. The inoculated plates were incubated at 26°C ± 2°C. Identification was through morphological and cultural characteristics exhibited by the fungal isolate.

Preparation of plant extracts

Botanicals were prepared using the procedures of Amadioha, (1999). Freshleaves of *Chromolaena odorata*, L. (Siam weed, Ewe Akintola), *Tetrapleura tetraptera*Taub. Preseke, soup perfume, African comb,Aidan),and *Vernonia amygdalina*Delile. (bitter leaf, Ewuro) were collected and air dried for 14 days after which they were ground with the aid of a mechanical grinder to powder. The two soft sides of *T. tetraptera* fruits were cut into 5cm segments (pulp) before grinding. Two solvents (water and ethanol) were used in extract preparation at 5%, 10% and 15% concentrations. Aqueous extracts were prepared by adding 5, 10 and 15g of leaf and pulp into a beaker and adding sterile distilled water until the 100 ml mark on the beaker. The contents in the beaker were thoroughly mixed and left to stand for 24 hours. Thereafter it was filtered with a Whatmann No.1 filter paper. Ethanol extracts were also prepared as above. All plates were incubated at 28±2°C for 5 days. Measurement was taken as the mean growth along the two axes on two pre-drawn perpendicular lines on the reverse side of plates. Data were analysed using ANOVA and means were compared using Fisher's Least Significant Difference (Fisher's LSD) at 5% Probability level.

In-vitro evaluation of botanicals for antifungal activity

In-vitro evaluation for antifungal activity was conducted using the agar dilution method described by Okhuoya, (2012). Two perpendicular lines were drawn at the bottom of each Petri-dish (Amadioha and Obi, 1999). One (1) ml of extract was introduced into sterile Petri-dishes, PDAwas added to the Petri-dishes containing the extracts and gently swirled to ensure homogeneity of mixture. Five (5) mm agar plug of 7 day old *Sclerotium rolfsii* culture was placed at the center of each petri-dish containing chloramphenicol amendedPDA (at the intersection of the two perpendicular lines), the experiment was arranged in complete randomized design in three replicates. The radial growth was measured at 24 hours interval for 96hoursand the percentage inhibition was calculatedusing the following formula;

%age inhibition =Dc- Dt/DC x 100,

Where; Dc = Diameter of colony in control plate, Dt = Diameter of colony in treatment plate

All the data obtained were subjected to analysis of variance (ANOVA) and means were compared using Fisher's Least Significant difference at 5% level of Probability ($P>0.05$).

RESULTS AND DISCUSSION

The results of both the aqueous and ethanol extracts of the three plant materials showed that solvent of extraction as well as concentration influenced the effectiveness of the materials to reduce mycelial growth of *S. rolfsii*(Tables 1 and 2) ($P>0.05$)) It was also observed that reduction in mycelial growth increased with duration of incubation. ($P>0.05$). Among the aqueous extract *Chromolaena odorata* gave the highest mycelial reduction(65.3%) at 15% concentration which was comparable to 65.6 obtained on

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plates treated with Mancozeb (P>0.05) however, there was no significant difference in mycelial reduction between the extracts of *T. tetraptera* and *V. amygdalina* aqueous extracts at the same concentration (15%) and recorded significantly lower mycelial reduction compared with *C. odorata* extracts. At 10 and 15% ethanolic extract concentrations *C. odorata* and *T. tetrapleura*gave similar comparable (64.2 and 60% respectively) effect on mycelial reduction from 48hours to 96hours which was similar to 65.6 obtained on Mancozeb. Among the ethanolic extracts,*V. amygdalina* gave the least activity (47.7%) in reducing mycelial growth of *S. rolfsii*. It was observed to besignificantly different to the control at 5% level of probability. At all tested concentrations the extracts were found to significantly inhibit the mycelial growth of *S. rolfsii* under *in vitro* conditions. All the extracts (aqueous and ethanol) significantly reduced the mycelial growth of *S. rolfsii* when compared with the control(Table 1 and 2). The effectiveness of the extracts increased with increase in concentration and maximum inhibition was recorded at 15%. The mycelial reduction activities of the extracts were solvent and concentration dependent. This is in agreement with the report of Ilondu (2012) and Chiejina and Ukeh (2013) who indicated that increase in the antifungal activities had corresponding increase in concentration of plant extracts. Edward, 2015 had reported effective activity of *C. odorata* on Cassava rot disease. Umana *et al*., 2016 had also reported complete inhibitory activities of *T. tetraptera* on *Penicillium* species in *Arachis hypogaea.*The differences in the effectiveness of the extracts could be attributed to the differences in their active ingredients and ability of the extraction solvent to release the active components in the plants (Onifade, 2002; Okigbo *et al*. 2009).The fungitoxic effects of these plant extracts indicate their potentials and thuscould be explored as part of sustainable Integrated Pest Management (IPM) strategy to manage Southern blight on tomato.

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Table 1: Inhibitory activity of aqueous extracts of *C.odorata, T. tetraptera and V. amygdalina* on mycelial growth reductionof *S. rolfsii*

Treatment	Conc.	24h	48h	72h	96h
		% Mycelial reduction			
C. odorata	5%	20.6	34.2	44.9	53
	10%	32.8	45.3	54.8	60.8
	15%	45.5	50.6	59.4	65.3
T. tetraptera	5%	1.10	20.6	34	45.2
	10%	4.8	21.8	36.3	47
	15%	10	24.7	41.6	48.6
V. amygdalina	5%	1.1	16.5	30.7	42.6
	10%	8.5	24.7	37.2	47.8
	15%	10.1	27.2	39.6	49.6
Check 1 (Mancozeb@2.5g/l)		11	37	49.5	65.6
check 2 (untreated plot)		0	0	0	0
LSD ($P<0.05$)		15	14.2	17.1	12.5

Table 2: Inhibitory activity of ethanol extracts of *C.odorata, T. tetraptera and V. amygdalina* on mycelial growth reduction of *S. rolfsii*

Treatment	Conc	24h	48h	72h	96h
		% Mycelial reduction			
C. odorata	5%	11.5	21.8	37.3	47.8
	10%	33.5	51.6	53.8	58.2
	15%	45	57.6	58.1	64.2
T. tetraptera	5%	25	44.5	43.9	53.8
	10%	31.5	50.5	51.5	59
	15%	35	50.5	53.8	60
V. amygdalina	5%	0	25.8	28.5	42.6
	10%	0	28.3	28.4	41.8
	15%	8.5	32.9	37.3	47.7
Check 1 (Mancozeb@2.5g/l)		11	37	49.5	65.6
Check 2		0	0	0	0
LSD ($P< 0.05$)		26	25	25	24

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Management of Pests and Diseases of Fruit and Root Vegetables in Home Gardens in Nigeria

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Abstract
Pestpopulation above threshold level reduces plant growth, yields and quality of produce. Home garden is not an exception. The study examined management of pest and diseases of fruit and root vegetables in home gardens in Nigeria.Stakeholders in communities around National Horticultural Research Institute (NIHORT) headquarter station (Ibadan, Oyo state) and three sub-stations (Kano, Gombe, and Imo states) were brought together during sensitization workshop on utilization of horticultural waste for health improvement and wealth creation. This also included home garden management.Home garden owners (345)around NIHORT communities were sampled for the study. Data were collected using well-structured questionnairesand analysed using descriptive statistics. Seven fruit and root vegetables were identified to be grown in the gardens.Tomato, okra and pepper were the most cultivated by 27.5%, 24.6%, and 18.8% respondents, respectively. Wilt on tomato was the disease with the highest frequency. Other diseases include leaf curl, blight, fruit rot, leaf spot, damping- off, mosaic, and mildew. Pests comprise of insect pests like aphids, whiteflies, grasshopper/locust, and Tutaabsoluta; birds and rodents. Chemical control method (50.5 %) was practiced mostly by the respondents, indiscriminate use of the synthetic chemicals was observed. Major sources of information on pest and disease control were government agricultural agencies (29.5%) and research institutes (10.1%). Many respondents were unable to identify pests and diseases on vegetables in their gardens. Awareness should be created on use of integrated pest management strategies in which complimentary approaches are combined to manage pests and diseases, with the use of synthetic chemical pesticides being the last resort.
Key words: Home garden, Vegetables, Pests, Diseases, Management.

INTRODUCTION

Home garden is a piece of land within the surrounding of a house where crops are grown and some livestock are also reared. Fruits, vegetables, spices and sometimes flowers are the major crops planted in home gardens in Nigeria. These crops are good sources of proteins, vitamins and antioxidants and other minerals for good health. Home garden is not primarily for income generation, but for use of the people in the communities. This is a common practice both at the rural areas and urban cities (Olajide-Taiwo*et al*., 2010).Pests and diseases are among the major constraints identified by home garden owners which reduce crop productivity/yield potentials (Olajide-Taiwo*et al*., 2010).

Any part (root, stem, leaf, fruit,) of crops cultivated in home gardens can be attacked by pests and diseases. The pests are mainly insects of different families and pathogens include fungi, bacteria, viruses, phytoplasma and nematodes. Plant diseases caused by fungi and bacteria are most common during the rainy season i.e. during wet and warm conditions. Viral diseases of vegetables occur mainly during the dry and warm seasons, when the insect vectors carrying the viral pathogens are most active. Nematodes thrive when temperatures are warm but they can feed on plant roots all year round. Nematode damage to the root system is hidden but the disease symptoms can be visible on the aerial parts of the crop (Agrios, 2005).

High population of pests above threshold level reduces plant growth and yields. Common practices used in pest and disease control includegood agricultural practices, chemical, biological, cultural

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and physical measures. Recently the adoption of integrated pest management (IPM) is advocatedin reducing the menace and the population of pests and diseases below threshold levelthereby makesthe use of synthetic chemicals the last resort(Lamichhane, 2017). This approach involves crop rotation, use of certified seeds, soil solarisation, use of compost / manure, manipulation of time of planting to avoid pests, regular weeding,removal of crop residues after harvest, and routine scouting for pests and diseases on home gardens. It is therefore very important to identify different pests and disease management practices utilized by garden owners to reduce the menace of pests and diseases. Therefore, the aims of this study were to ascertain the major fruit and root vegetables grown in communities around NIHORT stationsidentify major pest and diseases of fruits and root vegetables and to determine pests and disease management strategies among the garden owners.

METHODOLOGY

Sensitization workshops on home garden themed "Home garden for food and nutrition security" were organized by the National Horticultural Research Institute (NIHORT) , Nigeria, in her headquarter Ibadan, Oyo state (Southwest) and three sub stations in kano (Northwest), Gombe (Northeast) and Imo states (southeast). Participants at the workshops were from the communities around the institutes' locations. Data were collected from participants with home gardens. Structured questionnaires were used to collect data from them on the fruit and root vegetables planted in their home gardens, pests and diseases encountered and the management strategies employed to mitigate the pests and diseases. A total of 345 respondents were used. Data collected were analysed using descriptive statistics.

RESULTS

Fruits and root vegetables grown by home garden owners

Fruit and root vegetables grown by home garden owners around NIHORT include tomato, pepper, okra, carrot, melon, garden egg and cucumber. Tomato (27.5%), okra (24.6%) and pepper (18.8%) were cultivated mostly as fruit vegetables by the garden owners (Table 1). However, carrot was the only root vegetable mentioned by home gardeners.

Diseases of fruit and root vegetables grown in home gardens

Wilt was a common disease identified by the garden owners on tomato(4.9%), okra (0.3%), melon (0.6%), garden egg (1.2%), and cucumber (0.3%). Other diseases identified were leaf curl (1.2%), blight (0.6%), damping off (2.9%), fruit rot (0.3%) and nematode infestation (0.6%). Other diseases reported on fruit and root vegetables in home gardens in Nigeria include leaf rot, septoria leaf spot, mildew, mosaic, die back, chlorosis, soft rot etc. (Table 2).

Pests of fruit and root vegetables in home gardens

A total of twenty-three pests were identified by the respondents as infesting fruit and root vegetables in their home gardens(Table 3). Pest frequency ranged from 0.3- 5.2%.

Aphid was identified as a major pest of all the fruit and root vegetables in the study, except melon with tomato having the highest percentage occurrence (4.9%).Other pests identified on tomato include Tutaabsoluta, birds, rodents, grasshopper/ locust, thrips . Whiteflies infestation was also a major pest problem identified.

Pests and diseases management methods

Chemical control measure was the major pests (58.3%) and disease (50.5%) controlstrategy practiced by the home garden owners in the four locations

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(Table4). Physical method which include handpicking and trapping; organic method which include use of botanicals like neem extracts, ash, fruit lime were also practiced by few of the respondents. The least used control method was the cultural method.

Dosages of chemical used in control of pest and diseases

Many respondents used the recommended dosages of the chemicals as prescribed on the manufacturers' label (48.7% for pests and 37.0% for diseases control). Never the less, 8.8% and 8.7% respondents were unable to mention the quantities they used for pest and diseases control respectively; while 3.6 and 10.3% used self-recommended dosages like a handful, a tinful, match boxful , a little for control of pests and diseases respectively (Table5).

Sources of information on treatment applied by garden owners

Government agricultural agency (29.5%) and research institutes (10.1%) were the major sources of information for pests and diseases control among respondents. A few make use of agro dealers (4.5%) and training workshops (3.3%) (Table 6).

DISCUSSION

Fruit and root vegetables grown by home garden owners around NIHORT include tomato, pepper, okra, carrot, melon, garden egg and cucumber.Some of these crops were reported by Aworinde*et al.* (2013).However, carrot was the only root vegetable mentioned by home gardeners. This may be due to the fact that they are mostly short duration crops that are consumed daily in Nigerian homes.

Common diseasesidentified by the garden owners on fruit vegetables in the study areas include wilt, leaf curl, blight, damping off, nematode infestation, leaf spot, mosaic, and chlorosis, All the mentioned diseases are of economic importance in fruit vegetable cultivation (Agrios, 2005).Chemical method of control was mostly employed by the respondents, this may be as a result of availability of the various agrochemicals (pesticides) in the markets and the convenience of use; and the effectiveness of the agrochemicals within a short period of time (Damalas, 2009). Whitten *et al.* (1996) andTilman*et al.* (2002) also noted that the high use of agrochemicals was due to high quality and quantity of crop yields. Indiscriminate and excessive use of agrochemicals by farmers can lead to environmental pollution of soil, air and ground water; destruction of natural ecosystems,development of resistance in pests and pathogens, beneficial insects, and wild animals (Damalas, 2009, Lamichhane, 2017).

Government agricultural agenciesand research institutes were the major sources of information for pests and diseases control among respondents.This could be due to the proximity of thestudy areas to the organisations.

A large percentage of respondents did not answer most of the questions pertaining to pests and diseases, probably because they do not have good knowledge of identification of diseases and pests of crops.

CONCLUSION AND RECOMMENDATION

Home gardens in communities around NIHORT stations in Nigeria are faced with challenges of several pests and diseases on their cultivated fruit and root vegetables. Chemical method was the mostly used control measure against the menace of the pests and diseases by the home garden owners. Many respondents did not respond to questions on pests and diseases probably because many of them could not really identify the pest and disease problems on their home gardens. There is a need to education the farmers on identification of pest and diseases and create awareness on the dangers involved in indiscriminate use of chemicals and also educate home garden owners on safety precautions involved in the use of

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agrochemicals on their home gardens. Integrated Pest Management (IPM) strategies should be introduced for adoption by the garden owners to minimize economic, environmental and health risks.

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Table1: Frequency distribution of fruit and root vegetables grown by home gardeners

Fruit and root vegetable	Frequency	Percentage	Ranking
Tomato	95	27.5	1
Pepper	65	18.8	3
Okra	85	24.6	2
Carrot	6	1.7	7
Melon	13	3.8	6
Garden egg	28	8.1	5
Cucumber	37	10.7	4

Table 2: Frequency distribution diseases of fruit and root vegetables in home gardens

Fruit veg. / Disease	Tomato	Pepper	Okra	Carrot	Melon	Garden egg/egg plant	Cucumber
Wilt, fusarium, verticillum	17 (4.9)		1 (0.3)		2 (0.6)	4 (1.2)	1 (0.3)
Leaf curl	4 (1.2)	9 (2.6)	7 (2.0)			4(1.2)	4 (1.2)
Leaf spot/bacterial spot	1 (0.3)	4 (1.2)			1 (0.3)		
Bacteria	1 (0.3)	4 (1.2)	5 (1.4)			4 (1.2)	4 (1.2)
Blight (early plate)	2 (0.6)						
Smut	4 (1.2)		1 (0.3)				
Fruit rot	1 (0.3)						
Blast	1 (0.3)						
Fungi/damping off	10 (2.9)	11 (3.2)	13 (3.6)				11 (3.2)
Nematode	2 (0.6)		4 (1.2)				
Decay	2 (0.6)	7 (2.0)		2 (0.6)			1 (0.3)
Yellowing/chlorosis	1 (0.3)		2 (0.6)				
Mosaic		1 (0.3)	6 (1.7)				2 (0.6)
Die back			1 (0.3)				

Table 3: Frequency distribution of pests of fruit and root vegetables in home gardens

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Fruit veg. / Pest	Tomato	Pepper	Okra	Carrot	Melon	Garden egg/egg plant	Cucumber
Ruminant (goats, sheep, cow)	2 (0.6)		3 (0.9)				1 (0.3)
Lizard	1 (0.3)						
Rodents (rat, squirrel, grass cutter)	3 (0.9)		1 (0.3)		4 (1.2)		1 (0.3)
Birds	4 (1.2)	1 (0.3)					
Worms	1 (0.3)		3 (0.9)				
Tutaabsoluta	4 (1.2)						
Thrips	1 (0.3)						
Whitefly	16 (4.6)	16 (4.6)	11 (3.2)				18 (5.2)
Army worm	1 (0.3)						
Aphids	17 (4.9)	11 (3.2)	7 (2.0)	1 (0.3)		6 (1.7)	4 (1.2)
Termite	1 (0.3)	1 (0.3)					
Caterpillar	1 (0.3)	1 (0.3)			2 (0.6)	1 (0.3)	2 (0.6)
Weevil/beetle/pod bug	6 (1.7)		9 (2.6)		2 (0.6)	2 (0.6)	
Grasshopper/locust	2 (0.6)	3 (0.9)	12 (3.5)		1 (0.3)	3 (0.9)	
Stem borer	3 (0.9)		4 (1.2)				1 (0.3)
Cricket	3 (0.9)	5 (1.4)					1 (0.3)
Moth/butterfly	1 (0.3)	4 (1.2)	2 (0.6)			1 (0.3)	2 (0.6)
Flies	1 (0.3)	2 (0.6)	1 (0.3)				
Insect + leaf molus	7 (2.0)	3 (0.9)	4 (1.2)			1 (0.3)	1 (0.3)
Others	3 (0.9)	1 (0.3)	4 (1.2)			1 (0.3)	2 (0.6)
Apes (baboon + monkey)			1 (0.3)				
Ants (white ant)			2 (0.6)				1 (0.3)
Spider/spider mite			2 (0.6)			3 (0.9)	

Table 4: Pests and diseases management methods (%).

Management methods	**Tomato**	**Pepper**	**Okra**	**Carrot**	**Melon**	**Garden egg**	**Cucumber**	**Cummulative**
Pest management								
Chemical	68 (19.7)	42 (12.2)	42 (12.2)	1 (0.3)	2 (0.6)	17(4.9)	29 (8.4)	201 (58.3)
Biological	1 (0.3)	1 (0.3)	2 (0.6)			1 (0.3)	1 (0.3)	6 (1.8)
Mechanical	3 (0.9)	2 (0.6)	11 (3.2)		4 (1.2)	1 (0.3)	2 (0.6)	23 (6.8)
Cultural	2 (0.6)		1 (0.3)			1 (0.3)		4 (1.2)
Biochemical	2 (0.6)	2 (0.6)	6 (1.7)			1 (0.3)	1 (0.3)	12 (3.5)
Disease management								
Chemical	52 (15.1)	43 (12.5)	37 (10.7)	6 (1.7)	1 (0.3)	13 (3.8)	22 (6.4)	174 (50.5)
Biological	4 (1.2)	1 (0.3)	3 (0.9)					8 (2.4)
Mechanical	2 (0.6)	1 (0.3)					1 (0.3)	4 (1.2)
Cultural			1 (0.3))					1(0.3)
Biochemical	2 (0.6)	3 (0.9)	6 (1.7)			1 (0.3)	1 (0.3)	13 (3.8)

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Table 5: Dosage of treatment used in home garden

Dosage	Tomato	Pepper	Okra	Carrot	Melon	Garden egg	Cucumber	Cumulative
Pest control								
No dosage	8 (2.3)	4 (1.2)	12 (3.5)		2 (0.6)	2 (0.6)	2 (0.6)	30 (8.8)
Prescribed dosage	58 (16.8)	38 (11.0)	28 (8.1)	1 (0.3)	1 (0.3)	13 (3.8)	29 (8.4)	168 (48.7)
Self recommendation	4 (1.2)	2 (0.6)	4 (1.2)			1 (0.3)	1 (0.3)	12 (3.6)
Disease control								
No dosage	12 (3.5)	6 (1.7)	10 (2.9)	1 (0.3)		1 (0.3)		30 (8.7)
Prescribed dosage	38 (11.0)	37 (10.7)	23 (6.7)	5 (1.4)		6 (1.7)	19 (5.5)	128 (37.0)
Self recommendation	9 (2.6)	5 (1.4)	10 (2.9)			7 (2.0)	5 (1.4)	36 (10.3)

Table 6: Information sources for pest and disease control

Information sources on pest control	**Tomato**	**Pepper**	**Okra**	**Carrot**	**Melon**	**Garden egg**	**Cucumber**	**Cummulative**
Research Institute	13 (3.8)	8 (2.3)	7 (2.0)	1 (0.3)			6 (1.7)	35 (10.1)
Agro-dealers	4 (1.2)	3 (0.9)	3 (0.9)		2 (0.6)	2 (0.6)	1 (0.3)	15 (4.5)
Family & Friends	7 (2.0)	3 (0.9)	6 (1.9)		2 (0.6)	3 (0.9)	3 (0.9)	24 (7.0)
Media	12 (3.5)	12 (3.5)	3 (0.9)			1 (0.3)	4 (1.2)	32 (9.4)
Training/Workshop	4 (1.2)	1 (0.3)	4 (1.2)			2 (0.6)		11 (3.3)
Govt. Agric. Agency	29 (8.4)	20 (5.8)	26 (7.5)			9 (2.6)	18 (5.2)	102 (29.5)
Disease control								
Research Institutes	9 (2.6)	5 (1.4)	11 (3.2)			3 (0.9)	1 (0.3)	29 (8.4)
Agro dealers	4 (1.2)	2 (0.6)	2 (0.6)		1 (0.3)	1 (0.3)		10 (3.0)
Family & Friends	3 (0.9)	2 (0.6)	4 (1.2)			1 (0.3)	1 (0.3)	11 (3.3)
Media	8 (2.3)	12 (3.5)	3 (0.9)	6 (1.7)			4 (1.2)	33 (9.6)
Training/Workshop	2 (0.6)		1 (0.3)				1 (0.3)	4 (1.2)
Govt. Agric. Agency	32 (9.3)	25 (7.2)	24 (7.0)			9 (2.6)	17 (4.9)	107 (31.0)

Production and Assay of the Toxic metabolite(s) produced by *Colletotrichum gloeosporioides* Penz. On Egusi melon (*Citrullus lanatus* (Thumb) Mansf.)

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Abstract
Anthracnose on 'Egusi' melon (Citrullus lanatus) leaves is caused by Colletotrichum gloeosporioides. On infected leaves, it is associated with a characteristic dark brown to black necrotic lesions which are irregularly shaped and surrounded by a yellow halo indicating the presence of toxic metabolites. Seeds of Egusi, Jatropha curcas, sorghum and cowpea were grown in pots filled with five kg of top soil and arranged in a Completely Randomized Design (CRD). Pure culture of C. gloeosporioides was grown in a modified Richard's B medium. Mycelia were harvested by filtration at 7 day- intervals and discarded. Chlorotic and necrotic symptoms were observed on plants inoculated with 28, 35, 42, 49, 56, 63 and 70 day-old culture filtrates, but was absent on control plants. The results from this study suggest the presence of toxic metabolite(s) in the cell free culture filtrates of C. gloeosporioides as symptoms induced by the filtrates on leaves were similar to those produced by the pathogen under the natural infection conditions.
Key words: Egusi melon (Citrullus lanatus), Anthracnose (Colletotrichum gloeosporioides), Cell free culture filtrates, Assay, Toxic metabolites.

INTRODUCTION

'Egusi' melon (*Citrullus lanatus* (Thumb) Mansf.) is a creeping, herbaceous annual vegetable crop commonly cultivated in West Africa for its edible nutrient rich seeds popularly called "Egusi" in most parts of Nigeria (Denton and Olufolaji, 2000). It belongs to the family Cucurbitaceae (Schippers, 2000). It originates from Africa, where it is cultivated in mixed cropping system with other crops like yam, sorghum and cassava in peasant farms (Adewusi *et al*., 2000). Melon seeds are nutrient-rich, thus they have been found to have value in various uses, including condiment in enriching the taste and appearance of local stew (Denton and Olufolaji, 2000). Nigeria is the highest producer of melon in Africa producing about 544,445 tons over an area of 721,502 ha with average yield of 7,546 Kg/ha followed by Republic of Congo (61,977 tons) and Cameroun (45, 213 tons) (FAO, 2015).

The crop thrives in tropical regions with sandy loam soil with pH 6-7 and can tolerate periods of low rainfall. It is also grown in commercial quantity in Southwest Nigeria, especially in some parts of Oyo, Ogun, Ondo, Osun and Ekiti States where it is a staple vegetable with its seed forming an important part of soup condiments (Kehinde, 2013). Its seed is commonly consumed in Nigeria as a thickening for sauces and 'egusi' soup, melon ball snacks ("robo" in Yoruba) and fermented melon seed condiment used in seasoning (ogiri in Yoruba). The oil extracted from the seed varies in quality and quantity depending on the cultivars (Adewusi *et al.,* 2000) and it is widely used for cooking, manufacturing of Magarine, salad oil and canned fish (Ajibola *et al.,* 1990). Egusi plays vital role in the farming system as a weed suppressant cover crop and for soil fertility enrichment (Achigan- Dako *et al.,* 2008). It is also used as mulch, leaving high residual nitrogen in the soil after harvest (Mba, 1983) thus, helping to maintain and restore soil fertility of gardens and fields or in land rehabilitation (Adewusi *et al.,* 2000).

In spite of the vast nutritional, economical and medicinal significance of melon seed, the production and yield of Egusi melon in Nigeria are very low owing to many factors which include excessive rainfall, high humidity, low soil pH and increased incidence of pathogens such as, fungi, bacteria, nematodes and viruses (Van der Vossen *et al.,* 2004). Egusi melon is a member of the group of crops referred to as neglected crops, having suffered more neglect than other members of the group (Ogbonna, 2013). Some of the fungal diseases reported on Egusi melon in Nigeria were Powdery mildrew (*Erysiphe cucurbitarum*), Downy mildew (*Peronospora cucurbitarum*), *Alternaria* leaf spot (*Alternaria cucumerina*), *Cercospora* leaf spot (*Cercospora citrullina*), Anthracnose disease (*Collectorichum gloeosporioides*), leaf blight, vine blight and fruit rot (*Didymella bryoaniae*) and Wet rot of flower and fruit (*Choanephora cucurbitarium*) (Kehinde, 2013). Teklay and Muruts (2015) reported that major fungal diseases of sorghum include: sorghum smut (*Sporisorium sorgh*), Loose smut (*Sphacelotheca cruenta*), anthracnose (*Colletotrichum sublineolum)* leaf blight (*Exserohilum turicum*). The following fungal diseases were also reported in *Jatropha curcas* such as: Powdery mildew, Stem canker and die back, *Phytophthora spp.* and *Pythium spp.* (damping off), *Fusarium spp.* (root rot) (Heller, 1996), *Cercospora jatrophae-curcas* leaf spots Kar and Das (1988), *Helminthosporium tetramera* leaf spots (Singh, 1983). Cowpea anthracnose is caused by the fungus, *Colletotrichum lindemuthianum*, while Cowpea brown blotch is caused by fungi *Colleotrichum capsici* and *C. truncatum* causing 75% yield reduction in Nigeria (Falade *et al*., 2017).

Anthracnose caused by *Collectorichum* species has been reported to be among the predominant fungal foliar diseases of Egusi melon in Southwestern Nigeria, with maximum disease incidence index of about 82-100% (Kehinde, 2011). *Colletotrichum* species are known to be hemibiotrophs, requiring living host cells initially but soon causing the death of the host cells in advance of the pathogen (Agrios, 2005). In many cases, death of the host cells is caused by the secretion of enzymes and production of toxins or a combination of both. It is conjectured that these toxic metabolites may be responsible for the causation of the chlorotic halo surrounding the leaf spots produced by *Colletotrichum* on 'Egusi' melon, hence the need to investigate the phenomenon. Therefore, in this study an attempt was made to isolate and identify the pathogen associated with leaf spot on Egusi melon, determine the pathogenicity of the pathogen, obtain the cell free culture filtrates of *Collectorichum gloeosporioides* and assay its phytotoxin on Egusi melon, Jatropha, Cowpea and Sorghum.

MATERIALS AND METHODS

The study was carried out at the Plant Pathology Laboratory and Roof top garden, Department of Crop Protection and Environmental Biology, University of Ibadan. Oyo State, Nigeria. Four test plants namely: Egusi melon, Jatropha, Cowpea and Sorghum were grown in five Kg pots and arranged in a Completely Randomized Design.

Isolation and identification of the pathogen

Infected Egusi melon leaves were cut into pieces of about 2-3cm from the advancing margin of the lesions, using sterile forceps, surface-sterilized in 10% of commercial Sodium hypochlorite for 1 minute, rinsed in 5 changes of sterile distilled water. Pieces of the sterilized leaf tissues were placed on the gelled agar at 4 peripheral points on the plates which were incubated at 28ºC for 3 days. The mycelial growth and acervuli development around leaves were observed, conidial masses picked

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from colonies which were suspected to be *Colletotrichum*, were sub-cultured on Potato dextrose agar (PDA) for 7 days at 28°C for further purification and sporulation of the fungal isolate.

Pathogenicity test

Pure cultures of *C. gloeosporioides* were obtained from single spore culture maintained on PDA. The mycelia of the full grown cultures were scraped with a sterile bent metal rod. The conidial suspension was prepared by flooding the plates each with 10ml of sterile distilled water and the fungal suspension was filtered using 4-layered sterile gauze. Spore density was adjusted to 2.0×10^6 spores/ml, using a haemocytometer (ART. NO.1280 Hospital & Homecare UK). A drop of Tween 20 (adhesive) was added per 10ml of fungal suspension prior inoculation to assure adhesion of the spores on Egusi melon leaves under surface (Shamin *et al*., 2008). Three healthy plants were sprayed each with 10ml of the spore suspensions, while two healthy plants were sprayed with 10ml of sterile distilled water served as control. Inoculation was done by spraying the conidial suspension on 28 days old Egusi melon plants. To ensure uniform and dense infection of all leaves, inoculation was repeated by gradually rotating the pots so that each side faced upwards once. After inoculation, the pots were kept stationary for about 3 min to allow the spores to settle (Panday *et al*., 2012). Sterile cotton wool soaked in sterile distilled water were placed on the soil and were covered with a transparent polythene bag for 24 hours to create a humid condition so as to ensure the germination of spores, penetration of germ tubes and infection of the spores in the plant tissue by the germ tubes.

Host-Pathogen Relationship

Preparation of liquid medium (broth)

The broth was prepared following slight modifications of Ikotun (1975), the medium which composed of (K_2HPO_4 - 1g, KH_2PO_4 – 0.5g, $(NH_4)_2NO_3$ – 1g, $MgSO_4.7H_2O$ – 0.5g, Peptone – 10.0g, Dextrose – 10.0g, Yeast extract – 1.0g, Distilled water – 1000ml), it was sterilized in an autoclave for 15 minutes at 121°C and allowed to cool. Seven days old pure culture of *C. gloeosporioides* was inoculated into the medium using a 3mm diameter agar plug containing the fungus and allowed to grow for 7 – 70 days at 28°C.

Assay of the culture filtrates of *C. gloeosporioides* on Egusi melon and other crops

Culture filtrates of *C. gloeosporioides* were obtained from the medium from 7, 14, 21, 28, 35, 42, 49, 56, 63, and 70 days of incubation. The culture was made cell-free by centrifuging it at 4,000 revolution per minute (rpm) for 15 minutes, the supernatant was tested for biological activity by placing 0.1ml in a rubber wells on Egusi (melon), Jatropha, cowpea and sorghum leaflets at their vegetative stage. A puncture through the epidermis with a sterile syringe facilitated entry of the filtrate into the leaves. Symptoms development was observed and recorded after seven days, the control leaves were inoculated with the broth not containing the pathogen and sterile distilled water.

Statistical analysis

Analysis of Variance (ANOVA) was carried out on observations recorded using SAS, 2004 and Duncan Multiple Range Test (DMRT) at 5% level of probability was used to separate the means.

RESULTS

Symptoms of anthracnose disease on Egusi melon caused by *C. gloeosporioides*

The symptoms of anthracnose disease on Egusi melon leaves are dark brown to black necrotic lesions that are irregularly shaped and appear on the lamina and center of the leaves and are surrounded by a yellow halo, which is an indication of the

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role played by the toxic substances secreted by the pathogen.

Pathogenicity test

Symptoms of the disease on leaves were observed 7 days after inoculation. Egusi leaves inoculated with the conidial suspension showed an irregular necrosis 5-10 days after inoculation which later coalesced along with a yellow halo. The infected leaves fell off from the plant at 14 days after inoculation while the control plants remained uninfected.

Production of spores by *C. gloeosporioides* and Identification

On Potato Dextrose Agar, a snow-white mycelial growth was observed 3 days after incubation which became greyish-dark at 5-7 days after incubation. The fungus began to produce spores at 10-14 days after incubation with abundant masses of conidia. Its spores when viewed under the microscope were hyaline, one-celled, non-septate, and ovoid to oblong, slightly curved or dumbbell shaped conidia (Plates 1 A and B) with setae as described by Barnett and Hunter (1998).

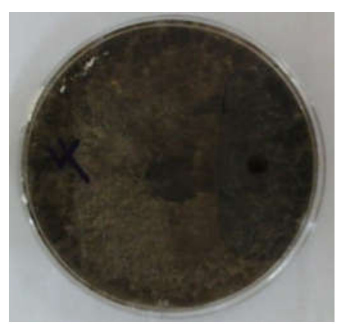
Growth of *C. gloeosporioides* in liquid medium

The fungus grew rapidly producing a whitish mycelia appearing in the medium 3-5 days after inoculation of medium. The mycelia turned grayish-black from 6 days after inoculation and incubation which later turned black at 9 days after incubation.

Assay of the cell free culture filtrates for biological activity on Egusi melon and other plants

It is evident from data presented in figure 1 that cell free culture filtrates (CFCF) obtained from fermented broth of *C. gloeosporioides* had a varied degree of toxicity against all the test plants. Maximum toxicity was recorded when leaves of each of the test plants were treated with CFCF obtained from 28 days old fermented broth. The initial symptoms observed within 48 h of treatment on the affected leaves were prominent spots which were surrounded by a yellow halo. At advanced stage, rapid browning of leaves and veinal necrosis of leaves was observed.

Egusi melon leaves inoculated with culture filtrates of 7, 14 and 21 day-old did not show any sign of infection, while leaves inoculated with 28 days old culture filtrate, produced small brown spots at 7 days after inoculation which ranged from 0.1-0.3 cm in diameter, 35 day-old culture filtrate induced necrosis on inoculated leaves that ranged from 0.1-0.3 cm in diameter at 3 days after inoculation which later enlarged to 0.2-0.4 cm in diameter at 7 days after inoculation. Culture filtrates of 42-70 day old caused severe dark spots surrounded by halo that ranged from 0.4-0.9 cm in diameter at 7 days after inoculation, which later advanced to marginal necrosis on inoculated leaves, the necrosis that was observed on melon leaves diffused towards the leaf lamina which later coalesced and later fell off from the mother plant at 14 days after inoculation. There were no signs of infection on the control plants as there were neither necrotic spots nor chlorosis on the inoculated leaves (plates 2 A and B).



A

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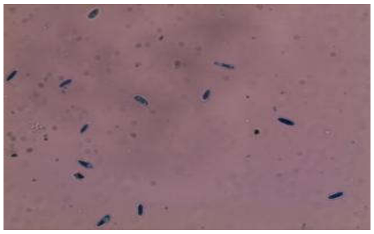


B

Plate 1: (A) Pure culture of *C. gloeosporioides* on PDA (B) Spores of *C. gloeosporioides* under the photomicrograph X40

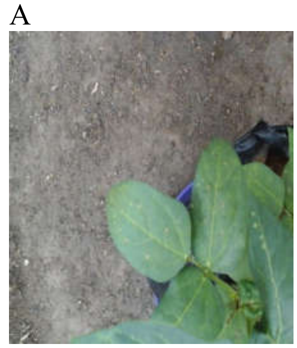
A

Plate 2: (A) Severe necrosis induced on Melon leaf inoculated with 35 day-old culture filtrate. (B) Control melon leaf inoculated with broth (not containing pathogen)

Cowpea leaves inoculated with culture filtrates of 7, 14 and 21 day-old caused no infections as there were no spots with a yellow halo on the inoculated leaves. However, leaves inoculated with 35 and 42 day-old culture filtrates induced dark brown spots that ranged from 0.2-0.3 cm in diameter 3 days after the leaves were inoculated. The area of the spots inoculated enlarged rapidly and extending causing marginal necrosis, while culture filtrates of 49-70 day-old induced severe necrosis from the point of inoculation ranging from 0.5-1.0 cm in diameter at 7 days from the point of inoculation, diffusing towards the leaf lamina which coalesced and surrounded by a chlorotic halo which later resulted to wilting of the inoculated leaves. The wilted leaves fell off from the plant 14 days after inoculation. Control leaves were unaffected, no necrosis, blights and tip die back (plates 3 A and B).

Culture filtrates of 7, 14 and 21 day old failed to cause infection on Jatropha leaves as there was no necrotic spots on the leaves. While necrotic spot surrounded by yellow halo was observed on leaves inoculated with culture filtrates of 28-70 day-old that ranged from 0.3-1.0 cm in diameter 7 days after inoculation, which advances from the point of inoculation surrounded by a yellow halo. No signs of necrotic spots on control leaves inoculated with culture filtrates void of the pathogen (plates 4 A and B).

A



B

Plate 3: (A) Tip die back with necrosis induced on Cowpea leaves inoculated with 49 day-old culture filtrate. (B) Control

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Cowpea leaves inoculated with broth (not containing the pathogen)

A

B

Plate 4: (A) Necrotic spots surrounded by halo induced on Jatropha leaf inoculated with 63 day-old culture filtrate. (B) Control Jatropha leaf inoculated with broth

There were no signs of infection on sorghum plants inoculated with culture filtrates of 7 and 14 day old. Sorghum reacted slightly to the culture filtrate of 21 day old; necrotic spot was observed on inoculated leaves 3 days after inoculation that ranged from 0.1-0.4 cm in diameter. 28 day old culture filtrate caused necrotic spots which were surrounded by a yellow halo on sorghum leaves, the spots enlarged beyond the point of inoculation 48 hours after inoculation, the diameter of the spot that ranged from 0.2-0.8cm at 7 days after inoculation. Culture filtrates of 35, 42, 49, 56, 63 and 70 days caused severe necrosis surrounded by a yellow halo, necrotic spots that ranged from 0.3-1.2 cm in diameter after 7 days of inoculation, the spots later coalesced after 10 days, with the yellow halo which diffused towards the leaf lamina causing drooping of the leaves 14-18 days after inoculation. There were no signs of infection on the control plants as there were neither necrotic spots nor chlorosis on the inoculated leaves (plates 5 A and B).

A

B

Plate 5: (A) Severe marginal necrosis induced on Sorghum leaf inoculated with 28 day-old culture filtrate. (B) Control Sorghum leaf inoculated with broth (not containing pathogen)

Discussion

From this study, the bioassay of the cell free culture filtrates of *Colletotrichum gloeosporioides* were found to induce necrotic lesions of varying sizes on all the test plants as reported by Jayasankar *et al*., (1999) that phytotoxins of all *Colletotrichum* are non-host specific. This is in agreement with the report of Amusa and Ikotun (1995) that toxic metabolites produced in culture by the *Colletotrichum* species exhibited a wide host range spectrum like the producing pathogen.

Cell free culture filtrates of *C. gloeosporioides* in several cases have shown the presence of an extracellular non-host specific phytotoxin (Gauri *et al*., 2008). The cell–free culture filtrates caused brown necrosis with variation in the size of necrotic spots among the test plants. Toxins injure host cells either by affecting the permeability of the cell

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membrane or by inactivating or inhibiting enzymes and subsequently interrupting the corresponding enzymatic reactions (Agrios, 2005). Test plants inoculated with culture filtrates of 7, 14 and 21 day old had no chlorotic or necrotic effect on the leaves, which indicates that *C. gloeosporioides* might not have produced any toxic metabolite in that short time or the amount of toxic metabolite produced might be insufficient to express symptoms on the leaves of the test plants (Naik *et al*., 1988). Wood (1967) stated that when a toxin is continuously produced in small amounts by a pathogen in an infected host, its effect may be first stimulatory, then inhibitory, and eventually lethal. This agreed with the activity of the culture filtrates on the test plants. Marginal necrosis, blights, tip die-back and wilting of the inoculated leaves which later fell off 21 days after inoculation was evident in all the test plants inoculated with 28-70 day old culture filtrates. But the time taken for symptom expression varied, the necrosis was observed as the spots gradually enlarged and clear chlorotic zones were formed around them 3-5 days after inoculation, as reported by Gauri *et al*. (2008) reported that symptoms induced by the filtrates were similar to those caused by the pathogen under the natural infection conditions. As the age of the culture filtrates increased, the time required to express symptoms decreased, indicating increased amount of toxic metabolite in the medium, but from the 56th day, the time remained constant. This could be due to the growth of the fungus in the liquid medium having attained the peak of toxin production. After this, the mycelia could have started degenerating resulting in death of the organism. The toxic metabolites of *C. gloeosporioides* were able to infect and induce necrosis which extended beyond the point of inoculation in Jatropha and other crops. Yoshida *et al* (2000) reported that in infected plants, parenchyma cells are damaged or killed in advanced of these pathogen and necrotic spots are typical symptoms. Also, the effect on the host may depend on where the toxin is produced. Thus, a toxin produced in the parenchyma such as occurred in the leaf toxin moves mainly through middle lamellae and cell wall routes obviously more slowly than through the vascular elements will usually cause local lesions, chlorotic spots, necrotic spots, and death of the affected tissues following the injury of cells which usually occurred in advance of the pathogen. The chlorosis indicated production of fungal metabolites that diffuse outwards from the invaded area towards the leaf lamina, which indicates the role of pathogenesis by the pathogen (Wood, 1967; Jayalakshimi *et al*., 2013).

The findings from this study was in agreement with Agrios (2005) that several toxic substances produced by phytopathogenic microorganisms have been shown to produce all or part of the disease syndrome not only on the host plant, but also on other species of plants that are not normally attacked by the pathogen in nature. Such toxins are called non-host specific; these toxins increase the severity of disease caused by a pathogen. Amusa (1996) reported that the ability of a pathogen to infect and invade a compatible host may be facilitated by the production of toxins that induce cell death in the proximity of the invading organism (Dangl and Jones, 2001). These toxins were also reported to play important roles in inhibiting the physiological processes in cells surrounding the point of infection, enabling the spread of the disease (Feys and Parker, 2000; Staskawicz *et al*., 2001). This is in agreement with the reports of Baker *et al*. (1997) that the virulence of an organism is sometimes enhanced by its ability to produce phytotoxins that kill cells in the tissue surrounding the point of infection. In some plant diseases,

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especially with yam anthracnose, toxins often produced a more rapid and extensive invasion by the pathogen than would be in the case in the absence of toxins (Amusa, 1991).

Thus, the toxic metabolite(s) of *C. gloeosporioides* was able to infect and induce necrosis which extended beyond the point of inoculation in Egusi and other crops. In addition, further characterization and purification of the toxin(s) of the pathogen should be done as this could be used for the production of natural herbicides in weed management because it will reduce the amount of potentially toxic chemical herbicides entering our environment.

Further work should be done in order to prevent desired crops planted from being affected in the field since the toxic metabolite of the pathogen is non-host specific.

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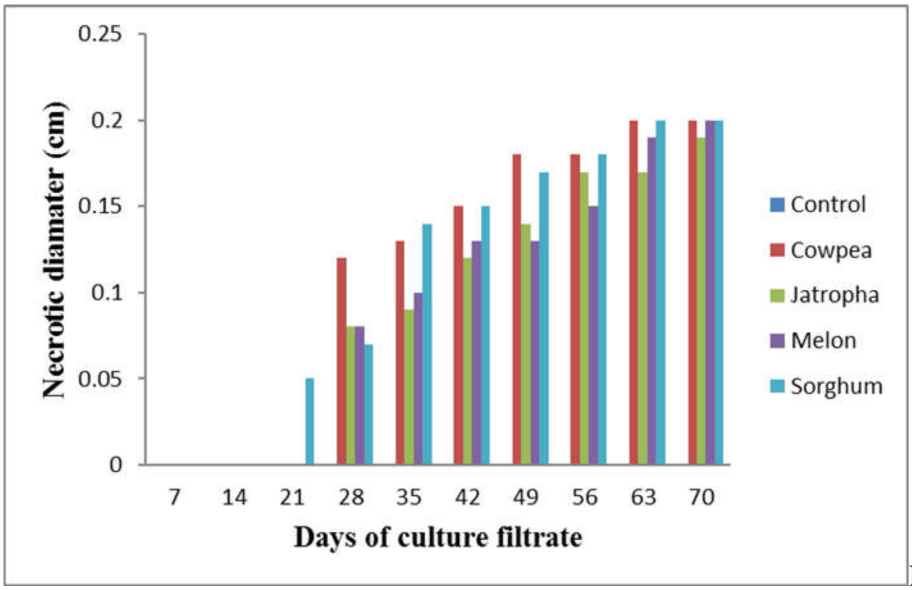

Fig 1: Necrosis induced by culture filtrates on test plants in a potted experiment

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Agroforestry Practices as a Panacea to Environmental Sustainability: A Case Study of Auyo Local Government Area of Jigawa State

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Absracts

The study ~~examines~~ agroforestry practices in Auyo Local Government of Jigawa State and evaluateseffectiveness in ameliorating environmental degradation. In carrying out this study, a reconnaissance survey of the area within the five major towns of the local government was embarked upon, and then followed by the interview schedule.From the data collected, it is observed that ifty seven percent of the total respondentshave been practicing agroforestry for the last 6-10 years in the study area. The study helps in addressing environmental degradations, and problems being encountered on the course of the practice such as land tenure problem, finance among others were realized. It was recommended that;NGOs should participate in agroforestry development, government's intervention in the provision of adequate and effective fast growing multipurpose tree species to farmers, and the provision of adequate teaching and training aids to extension units in order to educate more people to embrace and boost the practice of agroforestry in the study area and Jigawa State at large.

Keywords: Agroforestry, Environment, ameliorating

INTRODUCTION

One major problem confronting human kind today is the need to sustain the earth and its finite natural resources. The traditionally extensive system of food crop production, which is known to be stable and biologically efficient, operates effectively only when there is sufficient land to allow a long fallow period to restore soil productivity, which is exhausted during the short cropping cycle (Kang, 1986).

Over the years, however, agroforestry system has undergone rapid changes because of socioeconomic factors, mainly population growth, which has reached alarming rates in many developing countries in the last few decades (Nomara, 1984). The population growth has put severe pressure on the availability of fallow land and has led to increased deforestation.

Increased rates of deforestation, unsustainable agricultural land use, and severe soil degradation are creating widespread poverty and environmental degradation in developing countries (NAS, 1993; Swift, 2007). Each day, the world loses about 125 square miles of its forests, that's 34.5 million acres (14 million hectares) every year (FAO, 1996). Most of this takes place in the developing countries of the humid tropics. Reforestation efforts are limited to only about 10% of the total area and most efforts are not promising (Lamb, *et al.* 2005).

STUDY AREA AND METHODOLOGY

Description of the study Area

The study area (Auyo Local Government) is located in Jigawa State of Nigeria. It lies between $12^0 21'36"$N and $9^0 59'8"$E and occupies a land area of $512km^{2.}$ The population of Auyo Local Government Area is estimated as132,001 at the 2006 census. The local government came into being precisely on 22nd May, 1989.and its headquartersin the town of Auyo.

Predominant ethnic groups in Auyo are Hausa-Fulani, but other ethnic groups, such as Yoruba, Kanuri and Igbo are also present in the area.

Method of Data Collection

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In carrying out this study, a reconnaissance survey of the area within the five major towns of the local government was embarked upon, and then followed by the interview schedule. The reconnaissance facilitated identification of people that were interviewed as well as determined the sample size. Some field observations were made in order to overcome response taking and validate some of the reports and information to be collected.

Methods of Sampling

In this study, five major towns of the Local Government Area were selected. These includes Auyo, Ayama, Gatafa, Ayan and Unik representing extreme north, central and southern part of the L.G.A respectively engaged in Agroforestry practices. This was done to have fair coverage of the L.G.A., twenty people were sampled from five villages of each major town including the Local Government Headquarters, four from each village.

In each of the major towns, twenty (20) people who engaged in Agroforestry were interviewed. The response was 100%.

Data Analysis

The collected data were analyzed using simple percentage and frequency distribution methods.

RESULTS

Demographic characteristics of Respondents

Age:

Age is an important factor that determines to a very large extent the productive capacity of individuals. Thus, farmers in their prime ages will best endure the rigours of farm work and other related jobs than those in their older ages. The table 1 shows that 43% of the respondents are between the ages of 30-39 years, 28% of the total respondents are between the ages of 40-49 years, 15 percent of the respondents are between the ages of 20-29 years while 14 percent of them are of the ages of 50 and above.

Sex

On the sex composition of the respondents, 80 percentwere male while the remaining 20 percent were femalefemale. Majority of the respondents were male probably due to the cultural and religious reasons. Most of the females in the study area do not participate in farming activities and are not allowed to mingle with males. Only the single and few of the married ones are usually involved in such activities,

Length of time respondents practiced agroforestry

On the length of time agroforestry has been practiced, the information in Table 2indicates 51% of the total respondents have practiced agroforestry for the past 6 – 10 years in the study area.

Three major systems have been practiced. The most popular is agrisilvicultural system (i.e. agricultural crops and forest tree crops only) Agrosilvopastoral system (i.e. crops, pasture/animals and trees) are about of similar importance (Table 3).

Sizes of farm holding

Farm holding vary in size from less than one hectare to more than four hectares. Thirty per cent of the respondents had more than 4 hectares. Those with 2-3 and 3-4 ha are 24% and 25% respectively (Table 4)

Land Productivity due to Adopted Agroforestry Practices

More than two thirds (69%) of the total respondents opined that there was increment in the yield of their farm produce if compared to the yield about 5-10 years back. The remaining (31%) reported no increment.

Amelioration of Environmental Degradation due to Adopted agroforestry practices

There was widespread believe that the litter obtained from the tree stands improved the nutrient status of their soils, On the nutrient supply and erosion control, the information gathered, showed that 47% of the respondents have the view that

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agroforestry system improved the nutrient supply and at the same time controlled erosion to certain extent on the farmlands. More than half (53%) viewed that there is no noticeable change in terms of nutrient supply and erosion control on their farmlands. But most of the respondents agreed that where the tree stands are well established, the wind velocity is greatly reduced towards the leeward side.

Effect of agroforestry practices on reduction of fertilizer application

The results obtained show that 47% of the respondents noted that the amount of fertilizer application to improve productivity really reduced while 53% responded that the amount of fertilizer to improve productivity has not reduced.

Fuel wood Supply

Thirty per cent of the respondents believed that once the system is adopted in mass, the conflicts that arise due to the fuel wood extraction will be minimized if not totally stopped.

On the impact of agroforestry practices on fuel wood supply, result indicated that two thirds of the respondents (67%) has been positive as the supply of fuelwood has highly improved. One third (33%) of the respondents opined that they had not witnessed such improvements.

DISCUSSION OF FINDINGS

Indisputably, agroforestry offers a lasting solution if not a permanent antidote to the conflicting demand for land, for food, wood and animal production. Being a good example of multiple land use system, it accommodates many land users (Kareem, 2002).

Able – bodied people (men and women) are always needed in farming activities to make it successful and perpetual. According to (Ozo Eson, 1998), the low representation of women in forestry development can be attributed to several factors, some of which are cultural, traditional, social, economic, religious and political. To convince the populace to participate in agroforestry requires some strategies. According to (Dada and Adeola 1986) people either individually or collectively are involved in identifying problems and their cases and assessing the nature, scope and magnitude of interventions required to ameliorate them. It also involve helping people to analyze the risks involved and later to minor and evaluate to enable them adopt the activities required to achieve the desired result.

Agroforestry practice useto be one of the remediation measures of farmlands that are to be adhered to.

ICRAF, (1993) narrated how trees integrated with annual crops help to improve the soil status. For instance, species of Acacias produce root nodules which fix atmospheric nitrogen. The nodules appear to be highly active. The nitrogen – fixing ability of the specie, couple with the open canopy makes it potential value agroforestry specie, particularly during fallow – periods and scattered trees in crop land. Leaf litter is substantial, which helps to control weeds; these characteristics are recognized by local people.

Agroforestry improves household energy requirements. For example, Fagge, (2000) pointed out that the fuelwood consumption in Nigeria, Ghana, Liberia and Ivory Coast amounted to 93 – 96% of total wood production. Despite these consumption rates, the household energy survey revealed a net deficit of 5 – 8 million cubic meters. This deficit has caused rural communities to use cow dung and crop residues to supplement their house hold energy requirements. It is further pointed out that, the high demand for fuelwood in the semi – arid zone due to rapidly increasing population has further exacerbated by deforestation of natural and farmland vegetation and threaten aggravated environmental deterioration Extension is an educational process that communicates with farmers as individual and groups to

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help them learn and adopt knowledge, technology, skills and attitudes that bring about positive changes in their behavior which tend to increase crop and animal production, income, standard of living and rural development (Iyere, 2002).

The selection of the right tree species is important in agroforestry. According to Eremie (1994) multi – purpose speciessuch as *Acacia senegal*, *Philiostigma reticulata*that do not compete with the crops for water and nutrients by virtue of their canopy or rooting qualities are ideal for crop farms. In Silvopastoral where trees are a part of the pasture development, there is a preference for leguminous species which are capable of yielding copious amounts of fodder and maintaining productivity of the degraded lands usually devoted to pasture.

It is very important to involve the farmers in the planning and reorientation of agroforestry programmes and in particular in the choice of the species that meet their needs.

CONCLUSION

Environmental stability through sound ecological balance is very essential for continuous existence of man on earth. Man through his numerous activities aimed at development has severed the environment to such extent that human existence today is faced with many problems, a great number of which will not be solved except through the adoption of sound environmental management techniques aimed at increasing the vegetation cover. In Auyo local government, increase in the vegetation cover should not be left to government agencies alone but requires collective efforts from all and sundry.

Since greater part of the land is in the form of farmland any option that can ensure peaceful incorporation of tree on them will be very essential. One of such possible options available to us today is agroforestry. If properly augmented; agroforestry offers the advantage of not only ensuring a stable environment but in addition offering solution on the populace in various forms such as keeping perpetual productivity of the farmlands, eliminating the risk of failure associated with monoculture, averting conflicts between different farmers and above all ensuring effective and efficient utilization of available time, energy and resources.

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Table 1. Distribution *of respondents according to Ages*,

Ages	Frequency	Percentage %
20 – 29	15	15
30 – 39	43	43
40 – 49	28	28
50 and above	14	14
Total	**100**	**100**

Table 2: Distribution of respondents according to the time of practicing agroforestry

Time	Frequency	Percentage %
1 – 5 years	35	35
6 – 10 years	51	51
11 – 15 years	14	14
Total	**100**	**100**

Table 3: Distribution of Respondents by Agroforestry system practiced.

Agroforestry practice	Frequency	Percentage %
Agrisilvicultural system	25	25
Silvopastoral system	49	49
Agrosilvopastoral system	26	26
Total	**100**	**100**

Table 4: Distribution of Respondents by farm holding sizes (ha)

Farm holding size(ha)	Frequency	Percentage %
1	8	8
1– 2	13	13
2 – 3	24	24
3 – 4	25	25
Above 4	30	30
Total	**100**	**100**

An Analytical Review of Silvicultural Practices of *Anacardium occidentale*.

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Abstract
The silvicultural practices of Anacardium occidentalewere critically analyzed and reviewed. Anacardium occidentale is a tree of diverse genus of which dominates the tree flora of north-east of Brazil and the Caribbean. Its contribution towards environmental protection and economic development in the Sudano-sahelian is highly significant. The paper analyses and reviewed the main environmental and climatic factors supporting the growth and development of the plants. The climate, soil and water needs were fully analyses that suited for its growth and development.Anacardium occidentale also has many uses. Due to their fast growth, the foremost of these is the fruit. Beyond available literatures,Cashew was a crop suitable to many areas where climatic conditions and soils favourable to its growth exist

INTRODUCTION

The commercially cultivated Cashew *(Anacardium occidentale L.)* is a member of theAnacardiaceae botanical family, a family which also includes the mango *(Mangifera indica)* and the pistachio (Pistacia vera), (Oliver *et al.,* 1992). Among the eight species in the genus Anacardium, *Anacardium ooccidentale L* is the only one of economic value, due to its edible hypocarp and nutritious kernel.

Cashew is an evergreen tree native to North-eastern Brazil widely cultivated throughout the tropicsfor its very nutritious, free-of-cholesterol nuts. Its English name derives from the Portuguese namefor the fruit of the cashew tree that is known as “caju”, which in turn derives from the Tupi Indianname, acaju (Rosengarten, 1984; Davis, 1999; Maia et al. 2000). It is one of the first fruit treesfrom the New World to be widely distributed in the tropics by the Portuguese and Spanishadventurers (Purseglove, 1988). In the mid-to-late 1500s, Portuguese traders and explorersintroduced the cashew tree to India and to the east coast of Africa in an area that is nowMozambique with the purpose of afforestation and soil conservation (Red River Foods Inc., 2012).Later, in thesecond half of the sixteen century it was introduced to the continent’s west coast, where itpresently grows from Senegal to Nigeria (Red River Foods Inc., 2012).

Climate, Soil and Water Requirements *of Anacardium ooccidentale*

Cashew tree grows in temperate and tropical climate with rainfall from 200 to more than 1100mm annually, with a summer rains in the north and winter rains in the south of the continents. Nevertheless, an annual precipitation range of 1,000–2,000 mm is necessary for a good yield (Sys *et al.,* 1993). Yield performances reaching 3 t/ha are obtained under high temperature, especially within the range 15–35 °C, with the optimum between 24 and 30 °C. However, the optimal temperature for seed germination is around 35 °C (Dedzoe *et al.,* 2001). The tree is very sensitive to cold when young but becomes fairly hardy with age and is capable of withstanding short periods of light frost (Morton 1961).

Cashew can adapt itself to varying soil conditions from the sandy sea coast to laterite hill slopes, which has resulted in the selection of the worst soils for cashew where no other crops could give an economic return (Panda 2013). For maximum productivity, cashew prefers good well drained aerated sandy-loam soils with adequate moisture; however those soils are poor in fertility; hence the cashew tree need to be fertilized regularly (Panda 2013).

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Distribution

Plant native to the north-east of Brazil, and the Caribbean. From Senegal to Kenya, tropical Africa, Madagascar, West Indies.

Habitats

Species grown in Sudanese to Guinean savannahs on deep and light soils, on screes or gravels. For fruit production, 500 to 4,000 mm of rain over four or five months are necessary, and not too much wind during the flowering periodPurseglove (1988).

Seed Propagation of *Anacardium ooccidentale*

Cashew is propagated by both seeds and by vegetative methods. Seed propagation results in anenormous variability in the seedling progeny. Therefore, high yielding cashew varieties are commercially propagated by different vegetative methods to produce true to type planting material (Desai 2010).

Another way is to plant the seed in a plastic bag and then transfer the young tree seedling (approximately three months old) to the desired location. This type of seedling is usually developed at a tree nursery where it is easier to protect, care for, and monitor the tree seedlings (IRD, 2011).

Dormancy and Pretreatment of *Anacardium ooccidentale*

Before sowing, the viability of the seeds to be used as planting material need to be tested. To this purpose, a simple water test can be conducted. A hand full of salt must be added to 10 litres of clean water. Nuts are added and stirred vigorously. After 5 minutes all floaters are discarded. Only sunken nuts are to be used as seed. The residual salt must be washed away from seeds. Selected seeds must then be soaked for 2 days in clean water to obtain a good germination and finally air-dried (GIZ-ACi, 2012).

Sowing and Germination

Three seeds per hole/mound must be planted at a depth of 5 cm in a triangular pattern so as to avoid gasps in the plantation in case of seed failure (Dendena *et al.,* 2014). For seeds that have been stored for no longer than 5 to 6 months in gunny bags, and after been sun dried for 2 or 3 days, germination takes 15–20 days (Azam-Ali and Judge, 2001).

Growths and Adaptations

After germination occurs and when seedlings are near 20 cm in height, only the most vigorous seedling should be left and the weaker plants gently removed to allow room for the biggest to continue growing in the mound. When planted directly into the plantation, cashew seedlings are easily eaten by small rodents, termites, and other animals. They also require watering which may not be available. Moreover, some of the seeds planted may not germinate or survive.

Pest And Diseases

Pests

The most widespread biological constraints that hamper cashew productivity in Africa are the miridbugs, *Helopeltis sp.,* the coreid coconut bug, Pseudotheraptus wayi, and the powdery mildew(PMD), *Oidium anacardii* which can lead to 60-100% yield losses. In addition to the mirid pests, acomplex of stem borers also severely hampers production and greatly reduces the income ofsmallholder farmers, especially in West Africa (ICIPE, 2011).

Diseases

Among diseases caused by pathogens, those brought by fungi are the most dangerous andcashew is susceptible to over 10 of them (Cardoso *et al.,* 2013). Anthracnose foliar blight and fruit rot and gummosis of twigs and trunkare often considered the most relevant diseasescausing severe damages across cashew producing countries (Ghini *et al.*, 2011).

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In Nigeria, studies were conducted on the incidence and impact of these diseases, reporting the identification of C. gloeosporioides among other fungi (Otuonye *et al.,* 2014), and evidences of cashew gummosis (Adejumo, 2005; Adeniyi *et al.,* 2011). Twig dieback *(L. theobromae*) has remained a major factor limiting cashew production for decades in Nigeria especially on young cashew plots (Hammed and Adedeji, 2008). *Lasiodiplodia theobromae* can also affect the inflorescence, thus reducing the fruit bearing.

Flowering and Fruiting Habits

Adult plants grow from 8 to 14 m in height and develop a crown span that reaches up to 20 m (Johnson 1973; Ohler, 1979). They generally flower in their third year from planting, but the minimum age for stable production is usually 8 years and more commonly between 12 and 14.

The individual production capacity varies considerably, with plants producing less than 1 kg up to more than 100 kg of nuts per year. Similarly, a nut's weight can vary between 3 and 33 g, with the pseudo-fruit ranging from 20 to 500g. The dwarf type generally reaches no more than 5 m in height, with a homogenous canopy 5–6.5m wide. These plants have a notably shorter juvenile phase as they start flowering within 6 months so that they have a marketable production in their second or third year from planting (Barros, 1995; Barros *et al.,* 2002).

Uses

Cashew nut is a high value edible nut which is rich in vitamins, eaten fresh, dried, in jams, syrups or alcoholic drinks, coal and firewood. Used for reforestation because of its powerful root system helps fight soil erosion.

CONCLUSION

Cashew is a crop suitable to many areas where climatic conditions and soils favourable to its growth exist. Its profitability could be easily improved starting from the most important element of cashew value chain: the planting material. The cashew industry already plays an important role in the economic development of countries like Vietnam, India, Nigeria, Ivory Coast, and Ghana and should thus be considered a key contributor to the achievement of the United Nations Sustainable Development Goals.

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Physico-chemical Properties, Proximate Composition and Sensory Evaluation of Pineapple Fruits (*Ananas comosus*) Stored in Different Media

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Abstract
An experiment was carried out in the laboratory of the Department of Horticulture situated at the Federal University of Agriculture, Abeokuta (FUNAAB) to determine the postharvest quality and sensory acceptance of pineapple fruits stored in different media. Pineapple fruits were harvestedat colour break stage from the Directorate of Farms at FUNAAB and stored in the Evaporative cooling structure (ECS)- pots in pot design and ventilated wooden boxes (VWB) while those stored in the open shelf served as the control. The experiment was laid out in completely randomised block design replicated four times. Shelland pulp colour, physiological loss of weight (PLW), total soluble solids (TSS), total titratable acidity, pH, proximate contents and sensory acceptability of the fruits were evaluated at pre-storage and after storage at 11 days (DAS). Results showed that TSS contents of fruits increased with storage time while PLW and vitamin C contents of the fruits reduced with storage time in the media. However, fruits stored in the ECS had comparable vitamin C content with pre stored fruits. The crude protein, crude fibre and carbohydrates contents were comparable in fruits stored in all media. Shell colour change from green to full yellow was reduced in fruits stored in the ECS and had better sensory acceptability when compared with fruits stored in VWB and open shelf. The quality and sensory attributes of pineapple fruits were affected by storage media.
Keywords: *fruits, postharvest handling, quality, sensory attributes, storage,*

INTRODUCTION

Pineapple (*Ananas comosus*(L.) Merr) belongs to the *Bromeliaceae* family. It is a perennial monocotyledonous plant with a terminal multiple fruit, which is consumed fresh or as pineapple juice (Hossain, 2016). Pineapple is regarded as a healthy fruit being a diuretic,aids digestion, boosts the immune system, and showsanti-inflammatory and anthelmintic effects (Paull and Lobo, 2012).The fruit mainly contains water, carbohydrate, sugars, vitamins A and C, potassium and Magnesium. In 2016, Nigeria is the 7th largest producer of pineapple in the world, producing 1,591,276 tons with a worldshare of 6.2% from area harvested at 195,878hectares(Factfish, 2018). Pineapple variety of major commercial value is 'Smooth Cayenne' while other varieties produced on smaller scale include 'Red Spanish,' 'Queen,' 'Pernambuco,' 'Sugarloafs,' and 'Cabaiani' (Nakasone and Paull, 1998).

In pineapple production, the stage of fruit maturity is critical to quality at harvest (Wijesinghe and Sarananada, 2002).Immature fruit do not develop good flavour and sugar content is low. More so, pineapples have short postharvest shelf life at ambient temperature and deteriorate quickly (Lu *et al*, 2010). The environmental conditions under which pineapple fruits are stored therefore have a significant effect on its shelf life and postharvest quality. Hossain, (2016) stated that pineapples requires good storage condition to sustain its taste quality and market desirability. However, poor handling and inadequate storage facility are some of the major challenges of pineapple production in Nigeria. In view of these challenges, this study was conducted to evaluate the postharvest quality and sensory acceptability ofpineapple fruits stored in different media

MATERIALS AND METHODS

Pineapple fruits (Smooth cayenne variety) were harvestedat colour break stage from the Directorate of University Farms (DUFARMS) at the Federal University of Agriculture, Abeokuta, Nigeria (FUNAAB) in November, 2017. The fruits were uniform in size, free from defects physical damages such as cuts, pests and diseases. The experiment set up in the laboratory of the Department of Horticulture in FUNAAB. The crowns were

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carefully removed, and the whole fruits cleaned and air dried. Five fruits of similar weight each were stored in evaporative cooling structure (ECS) pot-in pot design and ventilated wooden box (40cm x30cm x 25cm) while fruits stored in the open shelf served as the control. The experiment was set up in a Completely Randomized Design (CRD) replicated four times. An average temperature and relative humidity of 23.9°C and 86.2% RH; 30.1°C and 69.1% RH; 29.5 °C and 67.2% RH were observed in the ECS, ventilated wooden box (VWB) and open shelf respectively (Table 1).

Data collection

Data were collected at pre-storage and 11 days after storage (DAS) on parameters such as thephysiological loss in weight (PLW) which was calculated as the difference between the initial fresh weight (day 0) and the fresh weight at the time of sampling expressed as a percentage of the initial fresh weight. The shell color and pulp color of the fruits were evaluated using a colorimeter (CR-400/410). Total soluble sugar (TSS) was determined by placing juice from fresh samples on the reading surface of a hand-held Brix Refractometer (MF032ATC). Titratable acidity (TA, citric acid) was estimated by titrating with 0.1N NaOH solution to pH 8.1 and it was calculated as percent citric acid (Kimball, 1991). The pH was determined with the use of a pH meter (Jenway 3310) standardized with buffers 4 and 7. Ascorbic acid was estimated by the standard Indophenol dye method. Proximate composition was determined according to the standard methods of AOAC (2002). Sensory evaluation was determined by twenty trained panels that compared coded samples of some specified characteristics such appearance, taste, aroma and overall acceptability on hedonic scale of 1 to 9.

Data Analysis

Data obtained were subjected to analysis of variance (ANOVA) and means were separated using least significant difference at 5% level of probability.

RESULTS AND DISCUSSION

Physico-chemical properties of pineapple fruits stored in different media

There was loss in the physiological weight of the fruits with storage time in all the media. However, PLW was significantly reduced in fruits stored in the ECS at 11DAS compared with those stored in the ventilated wooden box and open shelf (Figure 1). This may be due to the low temperature and high relative humidity observed in the ECS which reduced the rate of water loss into the atmosphere from the fruits. The TSS content of the fruits increased with storage time in the different media however values obtained were comparable in all the media (Table 2). The increase in TSS may be due to the decrease in the organic acids present with storage which might improve the postharvest TSS. Sugar is one of the biochemical components of fruits and its concentration will determine the quality of the fruits (Siti Roha *et al*, 2013). Vitamin C contents of the pineapple fruits decreases significantly in fruits stored in the ventilated wooden box and room storage when compared with fruits at pre-storage and those stored in the ECS. Adisa (1986) stated that fruits and vegetables show a gradual decrease in vitamic C content as the storage temperature or duration increases. The TA contents of the fruits increased under room storage and perforated wooden boxes. The increase in TA may be due to the high temperature in the storage condition. Increase acidity under ambient storage condition was also reported by Paull (1997. The shell L a b colour hue values increased significantly with storage time from pre-storage however there was no difference in the pulp colour of the fruits stored in the different media (Table 3). Consumers usually judge the quality of pineapple fruits by the skin colour and

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aroma. However, high shell colour in pineapple fruits is not always a good measure of sweetness(Paull and Chen, 2013). Pineapple is a non-climacteric fruit in which eating quality is usually determined before harvest (Chen *et al*, 2010)

Proximate composition of pineapple fruits stored in different media

The moisture content of fruits generally reduced with storage time while ash contents and dry matter increased with storage time however, fruits stored in the ECS at 11 DAS had significantly higher moisture content compared with fruits stored in open shelf (Table 4). This may be due to the relatively high humidity observed in the storage chamber that reduced moisture loss to the atmosphere. The fat, carbohydrates and crude fibre contents of the fruits were similar both before storage and after storage in the different media. According to Kader (1992), pineapple fruits have no accumulation of starch there is no resolve for major postharvest quality improvements. Pineapple is a non-climacteric fruits that has no carbon source for promoting postharvest sweetening (Condenunsi *et al*, 2010).

Sensory acceptability of pineapplefruits stored in different media

The appearance and taste of the pineapple fruits stored in the ECS were liked moderately while the aroma was liked very much by the panelist when compared with other pineapple fruits stored in the ventilated wooden box and open shelf at 11 DAS. The appearance of pineapple fruits stored in open shelf were neither liked nor disliked while those stored in the ventilated wooden box were disliked moderately at 11 DAS after storage by the panelist. However, the taste and aroma of these fruits in were liked slightly. Overall, pineapple fruits stored in the ECS after 11 DAS were highly acceptable to the panelist (Table 5).Schulbach *et al.* (2007) reported that sweetness,pineapple flavor intensity, and off flavor were the most important quality factors in determining acceptability.

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Table 1: Average temperature and relative humidity observed in the degreening medium

Treatment	Temperature (°C)	Relative humidity (%)
Evaporative Cooling structure	23.9	86.2
Ventilated wooden boxes	30.1	69.1
Open shelf	29.5	67.2

Table 2: Physico-chemical properties of pineapple fruits stored in different medium

Treatment	pH	Total soluble solids (% brix)	Vitamin C mg/100ml	Titratable acidity (%)
Pre storage	3.59	14.70	15.74	0.74
Evaporative Cooling Structure	3.67	16.03	13.48	0.87
Ventilated wooden box	3.88	16.07	12.50	0.91
Open shelf	3.63	15.60	12.32	1.01
LSD 0.05	Ns	1.63	2.29	0.25

Table 3: Colour development on pineapple fruits stored in different media.

	shell colour			Pulp colour		
Treatments	**L***	**a***	**b***	**L***	**a***	**b***
Pre-storage	39.41	6.34	19.57	76.38	-2.63	35.24
Evaporative cooling structure	43.21	9.47	23.09	77.18	-2.56	39.17
Ventilated wooden box	46.84	10.85	28.60	78.88	-2.52	38.54
Open shelf	45.21	11.89	28.09	77.51	-2.85	35.11
Lsd (0.05)	1.44	3.42	3.65	ns	ns	ns

L*=lightness (0=maximum darkness, 100=maximum lightness) a= (+a* redness/ -a* greenness) b= (+b* yellowness/ -b* blueness)

Table 4: Proximate composition of pineapple fruits stored in different medium

	Moisture content (%)	Ash content (%)	Crude protein (%)	Crude fibre (%)	Fat (%)	Carbohydrates (%)	Dry Matter (%)
Pre storage	87.63	0.68	2.99	0.09	0.13	10.91	12.37
ECS	83.27	0.91	1.86	0.08	0.37	12.70	16.73
VWB	82.03	0.92	2.47	0.08	0.14	11.04	17.97
Open shelf	81.18	0.72	2.84	0.10	0.15	12.03	18.82
LSD 0.05	2.06	0.18	0.12	ns	ns	ns	3.54

ECS –Evaporative cooling structure, VWB- Ventilated wooden box

Table 5: Sensory evaluation of pineapple fruits stored in different media

Treatments	Appearance	Taste	Aroma	Overall acceptability
Evaporative cooling structure	7.3	7.7	8.3	8.0
Ventilated wooden boxes	3.9	6.9	6.8	5.2
Open Shelf	5.2	6.2	6.4	5.8

Hedonic scale: 1- dislike extremely, 2-disliked very much, disliked moderately, 4,- disliked mildly, 5-neither disliked nor liked, 6-liked slightly, 7-liked moderately, 8-liked very much, 9 –liked extremely.

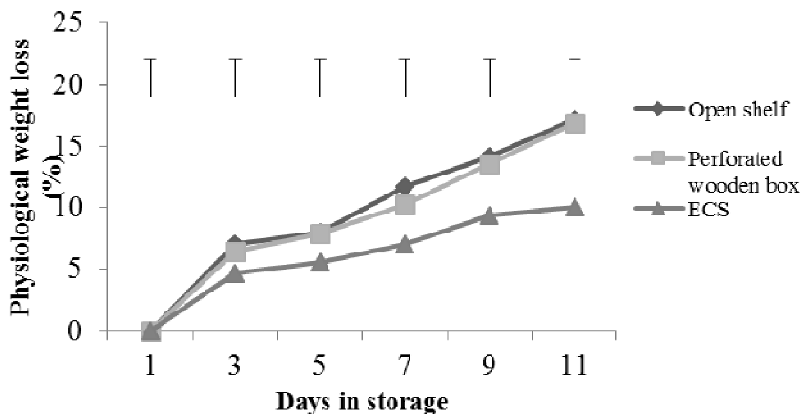

Figure 1: Physiological loss in weight of pineapple fruits stored in different media

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Effect of *Ocimum gratissimum* Leaf Extract on the Body Weight of Wistar Rats *(Rattus norvegicus)*

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Abstract
This research work investigated the effect of ocimum gratissimum (scent leaf) extracts on the body weight of wistar rats. Twelve adult wistar rats weighing 140-270 grams were used for the study. They were randomly assigned to six groups; 1, 2, 3, 4, 5 and 6. Group 6 rats served as the control group and were fed with rat chow and water only. Groups 1, 2, 3, 4 and 5 received 200, 400, 600, 800 and 1000mg ocimum gratissimum fresh extract, respectively according to their body weight. Appetite, behavior and body weight of the animals in all groups were observed for changes, and readings noted for an administration period of nine days. At the end of the study, result revealed that the treated groups showed observable weight loss. This study thus shows that ocimum gratissimum has a weight loss effect on the body.
Ocimum gratissimum, Leaf extract, Body weight, Wistar rats, Rattus norvegicus

INTRODUCTION

The history of the use of herbs in the management of disease dates back to the time of the early man (Kafara, 1994). In recent times, the use of plants for healing purposes is gaining popularity as it is believed that botanical plants are beneficial and free of side effects (Achinewu *et al*, 1995). Examples of such plants are *Codiaeum variegatum* for treatment of ulcer, stomach ache, and Chromo laena for healing wounds (Moundipa *et al*, 2005; Robert *et al*, 1988). The upsurge in the use of herbal medicine needs thorough scientific investigation into the plants healing activity in order to provide information on their safety or toxicity risk.

One of such plants widely used in Nigeria is *Ocimum gratissimum* (Scent leaf) also known as Clove Basil or African Basil. In Hawaii it is naturalized and known as wild Basil. It belongs to the family labiatae and it is the most abundant of the genus ocimum. It has an average height of 1-3m high. The leaves are broad and narrowly ovate; usually 5-13cm long and 3-9cm wide. It is a scented shrub with lime-green fuzzy leaves. Humans consume it food and medicine hence the need to find out the effect of *ocimum gratissimum* on the body weight of wistar rats and the relative effect of different concentrations of *ocimum gratissimum* on the body weight of wistar rats.

MATERIALS AND METHODS

Twelve Wistar Rats weighing 140-270grams were used for the study. The rats were purchased from the animal House of the College of Health Sciences, Ebonyi State University, Abakaliki. The animals were maintained at room temperature of 36 degrees Celsius and fed with growers mash manufactured by Top feed plc No. 2 Ojeowere Street Abakaliki, from an aluminum feeding trough twice daily and allowed water ad libitum. The rats were allowed to acclimatize for one week before the commencement of the study. The animals were randomly assigned to groups 1, 2, 3, 4, 5 and 6. Two animals were allotted to each group (rats were treated according to individual weights for specific body weight changes); groups 1, 2, 3, 4 and 5 were taken as the treatment groups while group 6 served as the control group. The animals were housed in metallic cages. They were cared for in compliance with applicable guidelines for animal research study.

Fresh leaves of *Ocimum gratissimum* were bought from Meat Market Abakaliki, Ebonyi state. It was identified by Professor Onyekwelu of Applied Biology Department, Ebonyi State University Abakaliki. Fresh leaves of ocimum gratissimum were rinsed in running tap water and drained using a dry sieve. The leaves were squeezed and the homogenate was sieved using a Muslin Cloth Sieve over a Funnel, and the residue discarded. The extract was evaporated under sun shade and a semi-solid paste obtained from it.

Plate 1: Picture showing fresh *ocimum gratissimum* leaf extract

Preparation of Plant Extract

1g each of the extract was measured out into 20ml sterile containers and stored in a refrigerator at 4^0c until required for use for all the treatment groups. Each stored extract was diluted with 10mls of distilled water before use each day.

Plate 2: Picture showing evaporated *Ocimum gratissimum* leaf extract

Plant Extract Administration

Administration was carried out once daily in all the groups for a period of nine days. However, on the third day (tagged day 'x') the animals received no administration but their feed and water, and their response and weight were noted. The appropriate conversion factors were calculated and the therapeutic dosages determined per body weight of the animals. The liquid extracts were administered to the animals by orogastric tube with a syringe attached to the end of the tube according to the animal's body weight.

Body Weight Measurement

The body weights of the animals were taken before administration daily, using a digital weighing balance.

Measurement of Food and Water Intake

Food and water given to the animals were measured daily and differences noted. Daily food and water intake was obtained by weighing the amount of food left in the food and water troughs after 24hours and subtracting it from the initial amount of food at start of the day's feeding. Same measurement was carried out for water taken.

Materials / Apparatus Used

- Fresh leaves of *Ocimum gratissimum,* Weighing balance, Distilled water, Muslin cloth (sieve), Funnel, Refrigerator, Round bottom flask, Metallic cages, Water / feeding troughs, Water bottles, Gloves, 20ml sterile containers, Colored markers, Biro and record book, Orogastric tube, 5ml syringe.

Body Weight Study

Generally, the control group (6) showed normal increment in body weight through the experiment period. The treated groups showed increasing weight loss on the first two days of administration, slight gain in weight on 'x' day and fourth day, and

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continuation with weight loss from the fifth day till the end of treatment period as administration continued. Weight loss is suggested to be possibly as a result of activation of the food and water centers of the hypothalamus, inhibiting hunger and causing loss of appetite.

Appetite Changes

There was significant reduction in quantity of food and volume of water intake in the treatment groups when compared to the control. An average feed of 10-12g were consumed by the control group daily, the treatment group however consumed decreasing quantity of feed over the experimental period, ranging from 5g and lower especially 8-10hours after administration.

Activity and Sensitivity Study

All treated groups showed reduced locomotion and activeness, decrease in sensitivity to touch increased through administration period. The control group however maintained activeness throughout the experimental period.

DISCUSSION

The result shows that the extract had negative effect on the body weight of the treated Wistar Rats when compared with the control group. At the course of the experiment, it was discovered that the control recorded relative stability in weight, increased sensitivity and active locomotion associated with normal appetite and feeding. However, in the treatment groups, it was revealed that the wistar rats showed observable loss of appetite, and recorded weight loss at the first two days of administration, slight gain of appetite and weight on the 'x' and fourth day; and followed with weight loss at the commencement of administration which continued through the rest of the administration period. The presence of other observable effects of the extract is an indication that the appetite of the wistar rats was altered (in this case reduced) by the extract. This might have been the reason for the weight loss. The rise and fall of the body weight between the 'x' day, fourth day and the latter days of administration is an indication that ocimum gratissimum may cause, and also ameliorate weight loss. Okun *et al*. (2012) studied the effects of aqueous leaf extract of ocimum gratissimum on streptozotocin-induced diabetic rats and reported that ocimum gratissimum affects the neuroendocrine regulation of intake by the gastrointestinal system, including nutrient sensing and peptide secretion by enteroendocrine cells leading to weight loss. Also, in his research, Cummings *et al.* (2007) explained that animals maintain a remarkable stable body weight because; the overall caloric ingestion and expenditure are exquisitely matched over long periods of time, through the process of energy homeostasis. To regulate food consumption, the brain must modulate appetite, and the core of appetite regulation lies in the gut-brain- axis (Cummings, *et al.* 2007). Furthermore, signals from the GIT are important regulators of gut motility and satiety, both of which have implications for the long term control of body weight (Drucker, 2007). Suppression of food intake is a function of the satiety centre in the ventromedial hypo-thalamus and, water intake is influenced by osmoregulators in the anterior hypothalamus that sense the osmolality of the body fluids. Therefore, Ocimum gratissimum may be stimulating the satiety centre while inhibiting the thirst centre (osmoreceptors) as well as hunger centre (lateral hypothalamic nuclei), (Okun *et al.* 2012) causing loss of appetite, satiety and hence loss of weight. The present study is useful for nutritional, therapeutic and medicinal counseling.

Conclusion and Recommendation

The fact that Ocimum gratissimum induces weight loss in wistar rats creates the anxiety over the major issue that might have initiated this activity. Therefore, there

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should be a need to carry out studies that further verify if histological changes do occur in the cytoarchitecture of the hypothalamus following the administration of *Ocimum gratissimum* extract. From the result of this study, it is concluded that *Ocimum gratissimum* (scent leaf) extract causes weight loss in the wistar rats.

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Results

Generally, the result indicates that *Ocimum gratissimum* has an effect on the body weight of wistar rats.

TABLE 1: Showing extract administration

Group	Dosage for group (mg)	Weight (g)	Dosage for individual weight(ml)
1	200	242.6	0.48
2	400	197.8	0.79
3	600	165.8	0.99
4	800	201.9	1.62
5	1000	305.1	3.05
6	Distilled water	197.3	Distilled water

TABLE 2: Daily Body Weight Measurements of the wistar rats

	GROUP WEIGHT (g)					
DAYS	**1**	**2**	**3**	**4**	**5**	**6***
1	242.6	258.6	207.4	201.9	264.3	187.4
2	224.3	149.3	198.8	172.2	246.1	197.3
3	230.5	154.9	203.7	179.8	251.4	207.1
4	252.1	169.8	201.4	166.6	235.7	219.4
5	224.4	168.9	200.1	163.2	263.2	225.3
6	219.7	157.3	191.7	158.8	249.9	233.6
7	198.3	141.1	183.5	148.2	220.3	241.9
8	178.2	129.7	169.3	122.6	212.8	250.2
9	159.4	119.9	150.1	114.5	202.5	259.0

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Proximate, Micronutrient and Functional Properties of Roasted and Sundried Groundnut (*Arachis hypogaea*) Flours

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Abstract
A study was conducted on sundried and roasted groundnut (Arachis hypogea) flouron the proximate analysis and functional properties using AOAC official methods. The crude protein ranged from 23.61-28.92%, crude fat 38.64- 46.11%, ash 2.05- 4.18%, crude fiber 3.1-4.64%, carbohydrate 18.12-23.64% and moisture 4.19-6.52%. The ash, moisture, carbohydrate, fat and fiber values of sundried and roasted groundnut flour proved to be significantly different. The bulk density ranged between 0.65g/cm3 and 0.67g/cm3 whereas water absorption capacities were between 8.18% and 8.46%. Swelling power ranged from 31.84mL to 34.00mL. Foaming capacity ranged from 4.66-11.45% and stability 33.08-58.34%. Samples showed no significant difference in terms of bulk density at P<0.05. The zinc content of the samples ranged from0.57mg/100g to 1.28mg/100g while the copper content ranged between 0.66mg/100g and 0.75mg/100g. The relatively high protein content of roasted groundnut flour as well as the functional properties makes it a valuable protein supplement in weaning foods as well as the treatment of protein energy malnutrition cases.
Key Words: *Arachis hypogea, proximate composition, functional properties, roasting. sundried*

INTRODUCTION

Nutrition is the study of food in relation to health of an individual, community or society and the process through which the food is used to sustain life and growth(*Whitney, et al., 2013, Woodside et al.,2005).* In order to have a healthy population that can promote development, the relation between food, nutrition and health should be reinforced. In developing countries, one of the ways of achieving this is through the exploitation of available local resources, to satisfy the needs of the increasing population (Achu *et al*., 2005). Knowledge of the nutritive values of local dishes, soup ingredients and local foodstuffs is necessary in order to encourage the increase cultivation and consumption of this highly nutritive nut. The consumption will help to supplement the nutrients of the staple carbohydrate foods of the poor who cannot afford enough proteins foods of animal origin (Achu *et al*., 2005).

Groundnut, *Arachis hypogaea* also known as peanut or earthnut is a native to a region in eastern South America. It is grown as an annual crop principally for its edible oil and protein rich kernels seeds, borne in pods which develop and mature below the soil surface. Thisplant isherbaceous with different varieties. The common varieties in the United States, grow up to 30-46 cm high and do not spread. Runner varieties, the most common in the West Africa are shorter and run along the ground for 30-60 cm. Peanut (*Arachishypogaea*) is now grown worldwide in the tropic and temperature zones primarily as an oilseed crop.

Peanut seeds make important contribution to the diet in many countries. These include its good nutritional value, as soup thickener and when cooked, roasted, dried or fried serve as snacks. Sometimes, paste used as margarine or butter. More so, they are less expensive, widely distributed easily cultivated, consumed and sold by the masses. Several studies have been

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carried out on the chemical and functional properties of kernels and defatted cakes of groundnut (*Arachishypogaea*) (Weiss, 1983,Bansal *et al*., 1993), which showed nuts as good source of lipid and protein and the defatted cakes could be used as protein supplement in human nutrition. The fatty acids composition of the endogenous fats ranges from 22 to 30% (Bansal,etal; 1993). And the average oil content may reach 50% and is a rich source of minerals (phosphorus, calcium, magnesiumand potassium) and vitamins (E, K, and B group)(Savage and Keenan, 1994). Groundnut protein isincreasingly becoming important as food and feedsources, especially in developing countries where proteinfrom animal sources are not within the means of themajority of the populace.

The oil content ofgroundnut differs in quantity, the relative proportion offatty acids, geographical location, seasons and growingconditions (Brown et al., 1975; Young et al., 1974). With increasing consumer preference for high quality edible oils in Nigeria and the desire to increase groundnut export to the world market, there is the need to investigate the quality of groundnut cultivars grown in the country. This study sought to determine the effect of different processing methods on the nutritional value of groundnut flour, which will form the basic information on the nutritional quality of groundnut for food processors and consumers.

MATERIALS AND METHODS

Sample Preparation: The groundnut was purchased from Lafia Market, Nasarawa State.The samples were taken to the laboratory for analysis. The groundnut was divided into two parts of 100g each, one part was roasted and the second part was sun-dried

.**Proximate Composition:** The moisture, ash, crude fibre and protein contents were determined in accordance with the method(AOAC,1990). Fat extraction was carried out by soxhlet extraction method (AOAC,1990).The carbohydrate content was determined by difference, subtracting the sum of moisture, ash, protein, fat, crude fibre percentage from hundred.

Determination of functional properties

The swelling capacity (SC): Swelling capacity was determined using the method described by Addis*et al;*(1992). 20 g of the food samplewas weighed into a cleaned, dried graduated cylinder. The cylinder was tapped 3 times on the table and then 80 ml of distilled water was poured into the cylinder. The cylinder was allowed to stand for 1hour after which the final volume of the food sample was noted. The ratio of the final volume to initial volume gave the swelling capacity. The supernatant was descanted and the weight of food sample and the cylinder was obtained, and the ratio of final weight to initial weight of the food sample gave the swelling capacity on weight basis.

The water absorption capacity (WAC): The water absorption capacity of the flours was determine by the method. (Sathe and Salunkhe,1981). One gram of sample mixed with 10 ml distilled water and allow standing at ambient temperature (30 ± 2ºC) for 30 min and centrifuging 30m min at 3,000 rpm or 2000 × g. water absorption was examined as percent water bound for per gram flour.

Oil absorption capacity: The oil absorption capacity was determined by the method of (Sathe and Salunkhe,1981). 1gram of sample mixed with 10 mL soybean oil (Sp. Gravity: 0.9092) and allow to stand at ambient temperature (30 ± 2ºC) for 30 min and centrifuge 30m min at 3,000 rpm or 2000 × g.

Emulsion Property: Emulsion property. The emulsifying activities and stability were determined using the (Neto *et al,*2001) with some modifications. 5ml of flour dispersion in distilled water (10mg/ml) was homogenized with 5mL for 1min. The emulsion were centrifuge at 101 rpm for 5min. the height (cm) of

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emulsified layer (ELH) and height of the total content of the tube (TC) were measured. Emulsifying capacity (EC) was calculated as EC % = (ELH/TC) × 100.

Emulsion stability (ES): was determined determine by heating the emulsion at 80°C for 30mins before centrifuging at 1100 rpm for 5min and was calculated as ES (%) = (ELHA/TCA) × 100; where ELHA = Height of emulsify layer after heating (cm) and TCA = height of total content before heating (cm). The effect of concentration emulsifying activity and stability of the flour was studied by preparing 2-10% W/V solution before conducting the experiment as described above

Foam Property: The foam capacity (FC) and foam stability (FS) was evaluatedby Narsyana and Narsinga (1982) method as described with slight modification. The 1.0g flour sample was added to 50mL distilled water at 30±2°C in a graduated cylinder. The suspension was mixed and shaken for 5min to foam. The volume of foam at 30sec. after whipping was expressed as foam capacity using the formula: AW= after whipping, BW=before whipping. The volume of foam was recorded 1hour after whipping to determine foam stability % of initial foam volume.

Gelatinization Property: Least gelation property was determined according to the method described by Coffman and Garcia (1977). Sample suspensions of 2 – 16% were prepared in distilled water. An aliquot (10 ml) each dispersion was transferred into a test tube and heated in a boiling water bath for 1hour, cooled rapidly in a cold water bath, and allowed to cool further at 4°C for 2 hours. The least gelation concentration was determined when the sample from the inverted test tube did not slip or fall.

Bulk Density: The bulk density (Packed Bulk density and Loose Bulk density) was determined using the procedure of Fagbemi (2008). A specified quantity of the flour mixes was put into an already weighed 5ml measuring cylinder (W1). For packed bulk density (PBD), it was gently tapped to eliminate air spaces between the flour mixes in the measuring cylinder and the volume was noted to be the volume of the sample used. The new mass of the sample and the measuring cylinder recorded as (W2). The Bulk density was expressed as:

$$B.D = \frac{W2 - W1 \quad X\ 100}{\text{Vol. of sample used}}$$

For loose bulk density (LBD), space was not eliminated by tapping.

Mineral composition: Mineral content (iron, zinc, manganese copper, calcium, magnesium, sodium, potassium, and selenium) of the flour samples was determined using an AOAC method (1990). Flour was digested with a mixture of concentrated nitric acid, sulfuric acid and perchloric acid (10:0.5:2, v/v) and analyzed using an atomic absorption spectrophotometer. The total phosphorus was determined as orthophosphate by the ascorbic acid method after acid digestion and neutralization using phenolphthalein indicator and combined reagent (AOAC, 1990). The absorbance was read at 880 nm (Spectronic 21 D, Miltonroy, New York, USA) and KH_2PO_4 (Merck, Mumbai, India) served as a standard.

Statistical Analysis: Data obtained were subjected to analysis of variance (ANOVA) and differences among the parameters were tested by the least significant difference (LSD) at ($P<0.05$).

RESULTS AND DISCUSSION

Results of the proximate composition of the sundried and roasted groundnut are presented in Table I. The carbohydrate content of the groundnut was highest with sundried groundnut flour 23.64% and least with roasted groundnut 18.12%. In a similar work conducted by Ayoola and Adeyeye, (2010) the carbohydrate contents sun dried and oven roasted (at 105°C)

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samples gave higher carbohydrate content of 27.19% and 36.11%, respectively due to the concentration of nutrients after dehydration. These high amounts of carbohydrates in sundried groundnut investigated confer on them, significant roles in human health especially in the supply of energy. The levels of protein in the roasted groundnut were relatively high. The least amongst them was in sundried groundnut which gave a protein content of 26.25% and was significantly different from the roasted groundnut recording the highest protein content of 28.93%. Generally the protein content recorded for sundried groundnut in this work is relatively greater than most pulses also the high protein content is desirable as some functional properties have long been associated with the activities of proteins. As shown in Table I, there were significant differences ($p< 0.05$) among the sundried and roasted groundnut with respect to crude fat. The fat content was highest with roasted groundnut 40.03% while it was least with sundried groundnut 38.64%. This presupposes that oils from this plant can be extracted and incorporated in to food or feed formulations requiring high levels of fat. In addition, the oil yield can be processed into cosmetics and biofuel. Crude fiber content in this study recorded the highest with roasted groundnut 3.13% while it was recorded the least with sundried groundnut 3.10%. These results are in line with results by (Khalid *et al.,* 2017). Close to other varieties of groundnut seeds (Atasie*et al*., 2009).The values of crude fibre obtained indicate that the groundnut varieties have the ability to give bulk to foods. The ash content in this study was relatively low, since the ash contains the minerals which can be estimated from it by atomic absorption spectrophotometry, it can be a good source of nutrients for consumers.The moisture content in this study was low, this makes the shelf-life to be long and contribute to the stability of *Arachis hypogeal* and prevent rancidity of the oil. Calorific value was highest with roasted groundnut with a value of 5075.30 kcal/kg and lowest in sundried with a value of 5059 kcal/kg. Such values of carbohydrate, protein and fat obtained have been suggested by (Eshun *et al.,* 2013) that groundnuts could be used to manage protein energy malnutrition. The highest value is slightly above that which was reported by (Eshun *et al.,* 2013).

Functional Properties of Sundried and Roasted Groundnut: The functional properties of roasted and sun dried groundnut flours are shown in Table II. Foaming capacity in Sundried and roasted groundnut ranged 4.66 -10.05 %. This result is similar to the findings of (Khalid *et al.,* 2017) who reported Foaming capacity of 4.0 -16.2 %. (Graham and Phillips 1976) linked good foaming properties to flexible protein molecules, which decreases surface tension. The foaming Stability of the samples was very high in sundried groundnut. Stability values ranged between 101.02% and 106.68%. This suggests the viscoelastic film formed via intermolecular interactions of constituent proteins is so strong that once there is formation of foam, its collapse is very difficult despite the low foaming capacity. As indicated by (Adebowale *et al*., 2005) defatting markedly increase the foaming capacity in the flours. Thus a fair balance of fat in the sundried groundnut could prove to yield high foaming stability cum capacity.

The results obtained from water absorption capacity (WAC) (8.18-8.46%) for the sundried and roasted groundnut can be found in Table II, there was significant difference ($p<0.05$) among the samples. The values obtained were low as compared to works of (Fekria*et al*.,2012). The main factor that can be attributed to the low nature of WAC is because of the heavy presence of fat within the samples.

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Literature is replete with data that suggests that WAC of defatted samples tend to be by far higher than those of undefatted samples as the presence of hydrophilic structures in fat restricts water movement. Flours with high WAC have more hydrophilic constituents such as polysaccharides. An observation made by (Ikegwu *et al.,* 2010) emphasized a positive correlation between swelling power and starch solubility in pure flours. A similar development was seen in the present study though whole sundried and roasted groundnuts were investigated. It can be seen from the result that, generally as the swelling power increased, solubility also increased. (Dengate 1984) also indicated that with respect to temperature, this is seen as a result of swelling permitting the exudation of amylose. The sundried and roasted groundnut samples, gave swelling power of 31.84g/g and 32.52 %. It is interesting to also note that, the sundried groundnut flour have more gelling properties 7.40% than roasted groundnut flour 15.18%. Statistically, there were no significant different (*$P<0.05$*) in the bulk density values obtained. This result disagreed with the findings of (Adebowale *et al*., 2005) whose values obtained ranged from 0.42 to 0.61 g/cm^3 in full fat flours and 0.72 to 0.88 g/cm^3 in deffated flours. High bulk density of the sundried and roasted groundnut despite high oil content indicates that they would serve as good thickeners in food products.

Mineral Composition: Table III shows the mineral composition of the samples. The importance of mineral elements can not be over emphasized in human nutrition. Zinc is an essential mineral that is Zinc is an element that is found in Zinc is found in a wide variety of As zinc is not a labile an element and important in immunity and growth The zinc content of the samples ranged from 0.57mg/100g to 1.28mg/100g. the result shows that the zinc content of roasted groundnut (1.28mg/100g) was significantly higher than the sundried groundnut(0.57mg/100g) at ($p<0.05$). The result of this study indicated a higher zinc content for the samples to be higher than those reported by Ayoola *et al. (*2012) and . Zinc deficiency is associated with no-specific signs such as growth failure, diarrhoea, and skin lesions. Dwarfism and hypogonadism have been shown to result from deficiency. However, High doses of elemental zinc ranging from 100 to 150mg/day for prolonged periods interferes with copper metabolism and causes low blood metabolism and causes low blood microcytosis, neutropenia, and impaired immunity.

The roasted groundnut has a lower copper content (0.66mg/100mg) than the sundried groundnut (0.75mg/100mg) but higher than the value for copper reported by (Obiakor-Okeke*et al;*2014) and this suggest that both samples are good source of copper. Copper is known to be an integral part of ceruloplasmin involved in the conversion of ferrous to ferric before its transportation. Copper also participates in several physiological processes including red and white blood cells maturation, cholesterol and glucose metabolism./

CONCLUSION

It can be concluded from the findings of present study that roasting of groundnut prior to de-fattening results in improvement ofboth the chemical and functional properties of the flours. The improvement in the functional properties of the groundnut flour ultimately increases its suitability for its utilization in a number of food products. Also, Heat processing improved the keeping quality, and utilization of the seeds and their oil extracts for domestic and industrial purposes.

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Table I: Proximate Analysis of Sundried and Roasted Groundnut flour.

Proximate Components	Sundried Groundnut	Roasted Groundnut
Moisture	4.19 ± 0.01^{c}	5.75 ± 0.03^{b}
Ash	4.18 ± 0.01^{a}	4.06 ± 0.01^{b}
Crude Protein	26.25 ± 0.02^{b}	28.92 ± 0.01^{a}
Crude fat	38.64 ± 0.02^{a}	40.03 ± 0.01^{a}
Crude Fibre	3.10 ± 0.01^{b}	3.13 ± 0.01^{b}
Carbohydrate	23.64 ± 0.03^{a}	18.12 ± 0.03^{c}
Energy	5059.00 ± 0.73^{b}	5075.30 ± 1.43^{b}

*Mean values of triplicate determination. Mean values within same row followed by different superscripts are significantly different ($p<0.05$).
**Values indicate mean±Standard Error of Mean*

Table 2: Functional Properties Sun dried and Roasted Groundnut flour.

Functional Properties	Sundried Groundnut	Roasted Groundnut
Swelling Capacity	32.52 ± 0.18^{b}	31.84 ± 0.33^{b}
Water holding Capacity	8.18 ± 0.08^{c}	8.46 ± 0.05^{b}
Oil absorption Capacity	9.14 ± 0.07^{b}	9.16 ± 0.05^{b}
Emulsion Activity	53.30 ± 0.07^{b}	52.22 ± 0.08^{c}

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Emulsion Stability	33.08±0.09[c]	58.34±0.05[a]
Foam Capacity	10.05±0.02[b]	4.66±0.02[c]
Foam Stability	106.68±1.11[a]	101.02±0.69[b]
Gelatinization Temperature	82.40±0.51[b]	82.60±0.81[b]
Least Gelation Concentration	7.40±0.18[c]	15.18±0.13[a]
Bulk Density	0.67±0.01[a]	0.66±0.01[a]

*Mean values of triplicate determination. Mean values within same row followed by different superscripts are significantly different ($p<0.05$).
**Values indicate mean±Standard Error of Mean*

Table 3. Mineral composition (mg/100 g) of sundried and roasted groundnut

Minerals (ppm)	Roasted sample	Sundried sample
Iron (Fe)	1.600 ± 0.350[a]	0.173 ± 0.001[b]
Zinc (Zn)	1.282 ± 0.002[a]	0.569 ± 0.003[b]
Magnesium (Mg)	14.627 ± 0.006[a]	11.550 ± 0.050[b]
Potassium (K)	3.600 ± 0.020[a]	3.420 ± 0.030[b]
Calcium (Ca)	28.220 ± 0.010[a]	19.630 ± 0.010[b]
Phosphorus (P)	0.693 ± 0.015[a]	0.653 ± 0.021[a]
Chlorine (Cl)	4.017± 0.021[a]	4.497 ± 0.370[a]
Selenium (Se)	0.004 ± 0.001[a]	0.002 ± 0.002[a]
Copper (Cu)	0.662 ± 0.002[a]	0.752 ± 0.002[b]
Lead (Pb)	-0.006 ± 0.001[a]	-0.002 ± 0.001[a]
Manganese (Mn)	0.014 ± 0.001[a]	0.092± 0.001[b]
Sodium (Na)	20.240 ± 0.050[a]	3.620 ± 0.015[b]
Cadmium (Cd)	0.007 ± 0.001[a]	0.003 ± 0.006[b]

Values are means (±SEM) of duplicate samples; means with different superscripts in the same row showsignificant difference (P < 0.05).

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Chemical and Sensory Quality of Complementary Foods Formulated from Sorghum (*Sorghum bicolor*), Soybean (*Glycine max*) and Groundnut (*Arachis hypogeal* L.) Blends

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ABSTRACT

Malnutrition is a major public health problem during childhood in developing countries. Using locally available food materials, Complementary foods were prepared from from sorghum(Sorghum bicolor), *soybean (Glycine max)and groundnut(Arachis hypogeal L.). Composite flours of the blends were formulated in the ratio 100:0:0, 75:15:10, 80:10:10, 85:10:5, 90:5:5 (sorghum, soybean and groundnut).The nutrient qualities of the formulated blends were evaluated. Results shows the crude protein content ranged from 18.33± 1.04 to 22.50±0.50%, fat content ranged between 12.00± 2.65 and 14.33±0.76% while the energy values ranging from 371.10 and 385.90Kcal/100g. Mineral determination revealed that iron content ranged from 16.52±0.001 to 25.09± 0.03mg/100g , Zinc (5.90±0.002 to 8.32±0.013 mg\100g) whereas Calcium ranged from 123.41±0.19 to 143.70±0.001mg/100g . A 100g portion of prepared complementary food in this study could meet daily requirements (%RDA) of energy (50-52%), fat (40-47%), protein (164-200%), iron (155-227%) and calcium(46-53%). The sensory evaluation found the formulated blends to have good acceptability. The addition of groundnut and soya beans improves the nutritive value of complementary food prepared from sorghum.*

Key Word: Sorghum, Soyabeans, malnutrition, mineral, formulated blend

INTRODUCTION

The optimum health and nutritional status of an individual is dependent upon regular supply of food and balanced diet. In the first year of life, infants undergo periods of rapid growth when nutrition is crucial. In fact, nutrition in the early years of life is a major determinant of healthy growth and development through childhood and good health in adulthood (Sule, 2014).

World Food Programme (WFP), (2008) observed that Protein Energy Malnutrition (PEM) continues to be a major health problem in Africa. Consequences of malnutrition include higher susceptibility to disease, higher mortality rate (and impaired physical and cognitive development (Muller and Krawinkel, 2005). In addition, it is difficult to compensate for poor growth after the first two years of life (Dewey and Brown, 2003).

Poor complementary foods with low nutrient density and inappropriate feeding practices have been identified as one of the major causes of malnutrition in young children (WHO, 2001).

Complementary foods are the traditional foods consumed between the time an infant diet consists exclusively of mother's milk and the time when the diet is made of family foods. Most complementary food used, are locally produced and based on local staple foods usually cereals that are processed into gruels and porridges. The local staple foods are reported as a probable factor in etiology of malnutrition (WHO, 2001), key elements characterizing African traditional complementary foods include high viscosity, low energy density and poor protein quality (Ejiugui *et al.,* 2007). These attributes have often been identified as causative factors of protein energy malnutrition (PEM) (walker, 1990). Cereal-based gruels are generally low in protein and are limiting in some essential amino acid, particularly lysine and tryptophan. Supplementation of cereals with locally available legumes rich in protein and lysine, although often limiting in sulphur, amino acids, increases the protein content of cereal legume blends and protein quality through mutual

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complementation of their individual amino-acids.

The unavailability of nutritious food and the high cost of commercial complementary foods and animal protein necessitate the development of nutrient-dense, safe, affordable and accessible complementary food from locally produced ingredients using household or small to medium scale production technologies The main objective of this study was therefore to formulate a reduced bulk nutrient-dense complementary food for children as well as evaluate the nutritional and sensory acceptability of the product.

MATERIALS AND METHODS

Collection and Preparation of samples

Sorghum (*Sorghum bicolor)*, soybeans (*Glycinemax)* and peanut (*Arachishypogeal*, *L*.) used for this work were purchased from Lafia modern market Lafia, Nasarawa state.

The food materials were cleaned and the mouldy or broken ones were manually removed. The grains were malted as described by Kulkarni *et al.* (1991) and cited by Anigo *et al*. (2010). The grains were watered twice daily and non-germinated ones removed.

Groundnut and soyabean were roasted separately as shown in (Figure 1). The food materials were milled separately into flour using the hammer mill and the composite flour of the complementary foods were formulated as shown in (Table I) and then stored in airtight containers at room temperature (25 - 30oC) until used. The formulated complementary foods were used to prepared Ready-to-eat diet as described by Anigo *et al.*(2010) by mixing flour in cold water at concentrations of 20% and then poured into water (200 ml) with the addition of 20 g of flour, stirred and allowed to remain heated for 15 min to form thick gruel, after which samples were taken for analyses.

Chemical analysis of Formulated complementary Diets

Moisture determination: Moisture content was determined by oven-drying as the loss in weight due to evaporation from sample at a temperature of 105°C. The weight loss in each case represented the amount of moisture present in the sample:

$$\text{Moisture (\%)} = \frac{\text{Weight of original sample} - \text{weight of dried sample}}{\text{Weight of original sample}} \times 100$$

Crude protein determination: The crude protein content was determined following the micro Kjeldahl method (AOAC, 2005). Percentage of nitrogen (N) was calculated using the following equation:

$$\text{Nitrogen (\%)} = \frac{(S\text{-}B) \times N \times 0.014 \times D \times 100}{W \times V}$$

Where D = Dilution factor, T = titre value = (S-B), W = weight of sample, 0.014 = constant value.

Crude protein was obtained by multiplying the corresponding total nitrogen content by a conventional factor of 6.25. Thus, crude protein (%) = % of N × 6.25.

Crude fat determination : Crude fat was determined by the soxhlet extraction technique followed by AOAC (2005). Fat content of the dried samples was easily extracted into organic solvent (petroleum ether) at 60 to 80°C and followed to reflux for 6 h. Percentage of fat content was calculated using the following formula:

$$\text{Crude fat (\%)} = \frac{\text{Weight of fat in sample}}{\text{Weight of dry sample}} \times 100$$

Ash determination: Ash content was determined by combusting the samples in a muffle furnace at 600°C for 8 h according to the method of AOAC (2005):

$$\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Crude fiber determination: The bulk of roughage in food is referred to as the fiber and is called crude fiber. Milled sample was dried, defatted with ethanol acetone

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mixture and then the experiment was carried out using the standard method as described in AOAC (2005):

$$\text{Crude fiber (\%)} = \frac{\text{Weight of residue} - \text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Carbohydrate determination: The carbohydrate content was estimated by the difference method. It was calculated by subtracting the sum of percentage of moisture, fat, protein and ash contents from 100% according to AOAC (2005):

Carbohydrate (%) = 100 – (moisture% + fat% + protein% + ash%)

Total energy determination: The total energy value of the food formulation was calculated according to the method of Mahgoub (1999) using the formula as shown in the following equation:

Total energy (kcal/100 g) = [(% available carbohydrates × 4) + (% protein × 4) + (% fat × 9)]

Mineral determination: Mineral element (P, Mg, , K, Na Ca, Mn, Cu and Fe concentrations were determined using Atomic Absorption Spectrophotometer (Hitachi,model 180-80). Phosphorus was determined Spectrophotometrically by the vanadomolybdate method (AOAC, 2005).

Sensory Tests: Sensory evaluation of the formulated complementary foods was carried out on the taste, appearance, aroma, texture, colour and overall acceptability by a 20 semi-trained adult panelists which includes mothers with children age 6 to 24 months and students in Faculty of Agriculture, Nasarawa State University, Lafia Campus using a 9-piont hedonic scale (Mellgaard *et al.,* 1991) which range between 1 (dislike extremely) and 9 (like extremely). The range method of statistical analysis was applied for the test of the significance to find the preferences.

STATISTICAL ANALYSIS

Analysis of variance (ANOVA) was used to test differences of nutritional value and sensory evaluation using Minitab . Least Significant Difference (LSD) test was used to test for significant difference between the samples at ($p<0.05$).

RESULTS AND DISCUSSION

The results of proximate analysis are shown in table II. The moisture content ranged from 12.50% to 15.07% with the highest found in sample D and lowest in sample A. Sample D had the highest moisture content of 15.07±0.12 while sample A had the lowest level of 12.50±0.50. There was significant difference ($p<0.05$) amongst the samples. The result shows that sample A will have the best storage stability amongst the samples having the lowest moisture content. All the samples had moisture contents appropriate for flours (12%-16%) (Gormet, 2015) this could be due to the drying temperature (65^{o}c) the materials were subjected to. Food materials to be used for complementary food should be allowed to undergo proper drying during processing so as to enhance their storage stability (Gormet, 2015).

The crude protein content is lowest in sample A (18.33±1.04%) and highest in sample B (22.51±0.50%). The crude protein content of sample B and C were significantly higher ($P<0.05$) than samples A,D and E. The crude protein content of all the formulated diets ((18.33±1.04 to 22.51±0.50%) were higher compare to the 6.37 ±0.23 to 7.88 ±0.28 obtained by Anigo etal(2010) for gruel prepared from malted cereals, soyabeans and groundnut but lower than the (36.40.12 to 40.01) reported by Eshun (2012). The high protein contents obtained in this studymay be due to complementation of soybean and groundnut are rich sources of protein which (Ejiugui et al., 2007) with sorghum. Natarajah, (1980), observed that soybean (*Glycine max*) and groundnut (*Arachis hypogeal* L.) are good sources of plant protein which contain 22% and 21% protein respectively. According to (Pamplona-Roger(2014),WHO recommended a minimum protein content of 15% is required for maximum complementation of amino acids in foods and growth thus, the formulation satisfies the protein demand of infants. Proteins are require in the diet to support growth and development in infants and young children. This is because legume proteins are high in lysine (limiting amino acid in most cereals) while cereals on the other hand are high in methione and cystine which are deficient in legumes (WHO, 2001). Therefore blending legumes with cereals provides desirable protein pattern that will enhance nutritional status of children.

The study observed lowest (12.00±2.65%) content of crude fat in sample D has and highest (14.33±0.76%) content in sample B. There was no significant difference between Sample B and C (P<0.05) in terms of crude fat but were found to be significantly higher than other (A,D and E) samples. The crude fat content obtained in this study was higher than when compared to the result reported by *Anigo et al* (2010) for gruel prepared from malted cereals, soyabeans and groundnut. Satter et al (2013) reported crude fat content of 11.32±0.25% for weaning foods which is similar to the values obtained in this study. It is suffice to say that the result of this study is within the range of 14.52 to 41.13% amount of crude fat specified for weaning foods by Codex Alimentarius (FAO/WHO1994). The high fat content in sample B can be attributed to the addition of soybean and groundnut to the cereals, which are oil seeds. The high fat level in the diet increases the energy density of the food (USDA, 2014).

Carbohydrate provides energy to the cells in the body particularly the brain, which is the only carbohydrate -dependent organ in the body (Effiong et al., 2009). The carbohydrate ranged from 38.93 ±2.11% in sample C to 46.47±2.30% in sample A. The carbohydrate levels of all the formulated samples were lower than the recommended lower limit(41.13 to73.79%) of the codex Alimentarius standard (FAO/WHO,1994) except for sample A (46.47%) which higher than the lower limit. The low Carbohydrate content observed in this study maybe due to the fact that carbohydrate varied and decreased with the addition of soybean and groundnut which is in agreement with the findings of Mahgoub (1999) who reported a decrease in carbohydrate content with increase in soybean flour fortification.

Energy contents is a parameter used to determine the quality of food, the energy content of between 371.1 and 385.9kcal/100g obtained for the formulated complementary food would meet 58.6% and 63.9% of a male and female child's daily requirement of 659kcal and 604kcal of a breast fed child aged 6-7 months respectively in line with WHO (2002). Energy values obtained for all the five formulations in this study was lower than the energy value (456.67±7.64) reported by Satter *et al*;(2013) and Anigo *et al;* (2010) for complementary foods.

The result of mineral composition of the formulated diet is presented in Table III. Minerals play important roles in the body system, their function include provision of building materials and aiding chemical processes in body system. The Codex Alimentarius standards (FAO/WHO, 1994) recommended that Calcim concentrations in weaning foods should have not less than 435.51 mg/100 g of the dry food. Calcium concentrations in the formulated foods Calcium ranged from 123.41±0.19 to 143.70± 0.001mg\100g. (Table III). In comparison with the standard, the formulated foods had Calcium concentrations below the minimum amount (435.51 mg/100 g) specified in the Codex Alimentarius Standards (FAO/WHO, 1994) . However, according to Food and Nutrition, Institute of Medicine (IOM, 2005), the Recommended Daily Allowances (RDA)

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for Ca for 7 to 12 months old infant 270 mg therefore a 100 g portion of the formulated foods would meet between 46 to 53% of the daily requirements (% of RDA). Iron is an essential micronutrient for the synthesis of hemoglobin (an oxygen carrier in the red blood cells), myoglobin (used for muscle contraction) and enzymes/coenzymes (used in various metabolic path-ways). Iron plays an important role in maintenance of specific brain, forms a vital component of certain enzymes and substances that aid in metabolism and helps in preventing infections (Whitney *et al*., 1990).Iron concentrations obtained in this study ranged from 16.52 ±0.001 to 25.09±0.003 mg/100gw a value that is higher than the 7.32 mg/100 g reported by satter *et al* (2012) for weaning foods and imported commercial weaning foods whose concentration ranged between 6.50 to 7.57 mg/100 g. The formulated foods had the iron concentrations above the minimum amount (4.8 mg/100 g) specified in the Codex Alimentarius Standards (FAO/WHO, 1994). A 100 g portion of prepared formulated foods in this study could meet the daily requirements (% of RDA) of iron by 155-227%. According to FAO/WHO (2001) minerals such as iron and zinc are low in cereals but the addition of legumes can improve the iron content which give credence to why sample A(100% Sorghum) had the lowest value compared to other samples.

Table 3 shows the mean scores of sensory evaluation of formulated complementary food by panelist. Mean scores ranges of attributes evaluated were: colour (7.11 to 8.39), flavour (6.28 to 8.12), mouth feel (6.11 to 8.11), consistency (6.56 to 8.06), and overall acceptability (6.83 to 8.06).

The sensory score by panelist were observed to be higher for samples where soybean and groundnut quantity was increased. Colour is an important attribute in food choice and acceptance. The high colour rating of the formulated sample will enhance the acceptability of the complementary food samples by the infants. The flavor ratings were observed to increase with increase in addition of soybean and groundnut. The increase could be due to the presence of flavor imparted by the oils in soybean and groundnut and the effect of roasting on both oil seeds (Mitzner *et al*., 1984). Isoflavones in soybean are effective in the prevention of osteoporosis via phytoestrogen effect that stops the neovascularisation in ocular conditions (Jiang, 2000). The sensations of taste and smell are function of flavor which is a complex sensation (Iwe, 2007). It is the flavor of a food that ultimately determines its acceptance or rejection even though its appearance evokes initial response. The malting processes method of the sorghum also increased the flavor of food samples. Malting results in the production of α-amylase, an enzyme that converts starch to soluble sugars (Taylor, 2003).

The mouth feel is very important in complementary food as it determines the amount of food an infant consumes since they can only swallow a smooth gruel not a coarse one. The mouth feel ratings were therefore within acceptable limit.

The sensory evaluation results obtained from the samples assessed by panelist, shows all samples were generally accepted but the panelist showed significantly higher preference ($p<0.05$) for sample B (mean score 8.06) compared to the rest of the formulated complementary foods. Complementation of sorghum with soybean and groundnut improved sensory quality of the complementary food samples. Thus, compositing of malted sorghum with soybean and groundnut did not impair the sensory quality of the complementary food. The results provides a basis for development of an acceptable complementary food that can provide the required protein and energy levels that are

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essential basic nutrients to enable accomplishment of a day's work.

CONCLUSION

The proximate analysis and sensory evaluation of the formulated complementary food shows that a blend of malted sorghum, soybean and groundnut gruel is nutritionally and organoleptically acceptable. The fact that these recipes are inexpensive, nutrient dense and locally available makes them potentially effective in solving the problems of protein energy malnutrition in the region that are devastated by this epidemic.

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Table 1: Formulated Complementary Food Blends

Sample	Sorghum %*	Soybean %**	Groundnut %***
A	100	0	0
B	75	15	10
C	80	10	10
D	85	10	5
E	90	5	5

* Malted sorghum ** Roasted soybean, *** Roasted groundnut

Table 2: Proximate Composition of Complementary Foods (%)

Samples	Moisture	Crude Fat	Crude Ash	Crude Protein	Crude Fibre	Carbohydrate	Energy (Kcal/100g)
A	12.50 ± 0.50^{c}	13.12 ± 0.83^{bc}	5.03 ± 0.58^{bc}	18.33 ± 1.04^{c}	3.33 ± 0.76^{c}	46.47 ± 2.30^{a}	371.1
B	14.33 ± 0.76^{b}	14.33 ± 0.76^{a}	6.60 ± 0.50^{a}	22.51 ± 0.50^{a}	4.33 ± 0.58^{b}	39.24 ± 0.99^{c}	385.9
C	14.35 ± 0.31^{b}	13.65 ± 1.26^{b}	6.56 ± 0.95^{a}	22.17 ± 1.04^{a}	4.33 ± 0.63^{b}	38.93 ± 2.71^{c}	381.7
D	15.07 ± 0.12^{a}	12.00 ± 2.65^{c}	5.76 ± 0.46^{b}	21.83 ± 2.75^{b}	4.75 ± 0.43^{a}	40.59 ± 2.44^{b}	381.9
E	15.03 ± 0.06^{a}	14.00 ± 0.50^{a}	5.10 ± 0.34^{bc}	20.87 ± 2.11^{bc}	4.25 ± 0.43^{b}	40.75 ± 2.03^{b}	371.2

Mean scores with the same superscript are not significantly different ($p<0.05$). Sample A (100:0) = 100% malted sorghum: control. B (75:15:10) = 75% malted sorghum+ 15% soybean + 10% groundnut. C (80:10:10) = 80% malted sorghum + 10% soybean + 10% groundnut. D (85:10:5) = 85% malted sorghum + 10% soybean + 5% groundnut. E (90:5:5) = 90% malted sorghum + 5% soybean + 5% groundnut.LSD = Least Significant Difference. S.E.M = Standard Error of Mean.

Table 4: Sensory Evaluation of formulated Complementary Foods.

Samples	Colour	Flavour	Mouth feel	Consistency	Overall acceptability
A	7.11 ± 1.75^{b}	6.28 ± 1.57^{c}	6.11 ± 1.71^{b}	6.56 ± 1.42^{b}	6.83 ± 1.43^{b}
B	8.39 ± 0.61^{a}	8.12 ± 0.99^{a}	8.11 ± 1.02^{a}	8.06 ± 0.87^{a}	8.06 ± 0.80^{a}
C	7.39 ± 0.78^{b}	6.83 ± 1.25^{bc}	6.89 ± 1.23^{b}	7.06 ± 1.06^{b}	7.33 ± 1.14^{b}
D	7.39 ± 0.69^{b}	7.11 ± 0.68^{b}	6.28 ± 2.08^{b}	7.06 ± 0.87^{b}	7.28 ± 0.96^{b}
E	7.17 ± 1.79^{b}	6.83 ± 1.51^{bc}	7.17 ± 1.86^{ab}	6.78 ± 1.31^{b}	7.56 ± 1.15^{b}

Mean scores with the same superscript are not significantly different ($p<0.05$). A (100:0) = 100% malted sorghum: control. B (75:15:10) = 75% malted sorghum+ 15% soybean + 10% groundnut. C (80:10:10) = 80% malted sorghum + 10% soybean + 10% groundnut. D (85:10:5) = 85% malted sorghum + 10% soybean + 5% groundnut. E (90:5:5) = 90% malted sorghum + 5% soybean + 5% groundnut. LSD=Least Significant Difference. S.E.M=Standard Error of Mean.

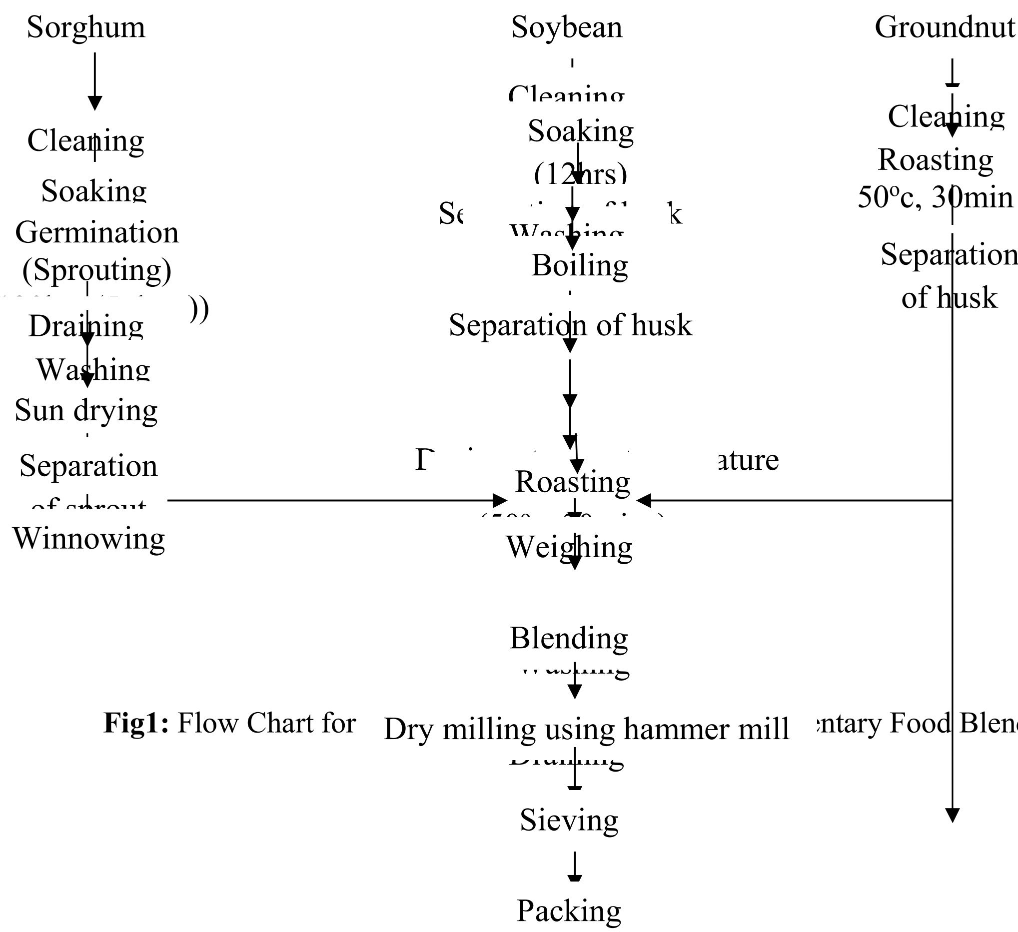

Fig1: Flow Chart for ntary Food Blend.

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Preliminary Evaluation of Physiochemical and Sensory Properties of Eight Mangoes Cultivars (*Mangifera indica L.*)

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Abstracts
In the present scenario, Nigeria mango is facing serious apprehension about production decline and export, consequently present study was designed -to categorize the dominant mango (Mangifera indica L.) cultivar in relation to its physical, chemical and sensorial attributes. Physiologically fully mature fruits of eight mango cultivars were picked from mango orchard of National Horticultural Research Institute (NIHORT) and subjected -tophysical and sensory analysis. Among the eight cultivars selected-(: Julie, Haden, Ogbomoso, Lipen, Patch, Palmer, Urlo and Edward).The variety with the highest - pulp weight, stone weight and peel weight is Edward with value of 289.9 (g), 47.6 (g) and 52.6 (g) respectively and the lowest variety in pulp weight is Lipen 112.8 (g), for stone weight Julie 22.52 (g) and peel weight is Ogbomoso 20.34 (g). For biochemical properties, Edward variety exhibited highest value for the ascorbic acid content with 48 mg/100g and the least found in Ogbomoso with 12.89 mg/100g. For total soluble solid (TSS), Ogbomoso variety exhibited highest value with 16.42 % and lowest found in both Patch and Palmer with 7.50 %. The sensoryattributes varied significantly @ p<0.05 according to cultivars. Out of eight cultivars, Haden obtained the overall best for satisfactory, followed by Edwardas first running best, whileOgbomosois the second running overall acceptability, andoverall best in taste.Both of these cultivars were equally acceptable for overall acceptability. However none of the cultivar is rejected by the panelists regarding the sensory evaluation.
Keywords: Mangoes cultivars, Sensory evaluation, Biochemical parameters, Physical properties

INTRODUCTION

Mango (Mangifera indica L.) is one of the important tropical fruits cultivated in many tropical regions and distributed widely in the world. Mango fruits are highly perishable, with a shelf life of 2–4 weeks, limiting their availability fresh in markets (FAO 2005). This food class is increasingly becoming a large proportion of the export products from the country and also for local consumption. Most fruits and vegetables have definite harvesting time and limited shelf-life, quickly deteriorating due to microbial and biochemical activities (Akhtar *et al*., 2010; Tahir *et al*., 2012). However, different preservation methods like processing into shelf stable preserves, juice and dry slices have been used to extend the shelf-life by a few weeks, one year or more (Abbassi *et al*., 2015; Abeyinghe *et al*., 2007). Value addition to Mango fruit will contribute to the reduction of post-harvest loss of especially fresh fruits in Nigeria (which is currently estimated at 50%) thereby adding value to the commodities (Aina and Oladunjoye. 1993). Processing of mango especially into dry slices will lead to distribution of this horticultural crops, create of entrepreneurial opportunities in food processing, generate wealth, reduce poverty and increase employment. (Jahurul *et al*., 2015; Razzaq *et al*., 2013).

Many mangoes varieties were cultivated in National Horticultural Research Institute, but the analytical studies required more investigations; to meet the demand of mangoes pulp for food industry and export the surplus.In view of the above aspects, the present study was-undertaken to throw light on some of the constituents of mango with a view to determining the most acceptable cultivar(s) into dried slices for local consumption and export apprehending the fruit as a supplementary food having a good calorific value as well as to select the varieties for plantation with a hope to be a member of the mango exporting countries.

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MATERIALS AND METHODS

The samples - were obtained from Mango orchard in NIHORT,eight mangoes varieties namely; *Julie, Haden, Ogbomoso, Lipen, Patch, Palmer, Urlo and Edward* were carried in separate paper bags. The fruit was thoroughly washed to remove dirt, dust, and micro flora on the surface of the fruit. Ten samples from each variety were taken, cleaned, cut into slices and dried with digital food dehydrator at 60 ^{0}C. All the biochemical parameters carried out in the study were performed by standard procedure of AOAC (Anon., 1990).

Organoleptic analysis: Organoleptic evaluation such as colour, flavor and taste was carried out with twenty panel member using 9 point hedonic scale (Akhtar *et al.*, 2010). The average of the score was considered taking Marks 1-10. The panel members were selected on the basis of their ability to discriminate and scale a broad range of different attributes of mango products. The judges were provided with prescribed questionnaires to record their observation. The information contained on the performa was 9 = Like extremely; 8 = Like very much; 7 = Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much; 1 = Dislike extremely. The panelists were expected to rate the dried mangoes slices and rinsed mouth with water between samples (Rajwana *et al.,* 2010).

DISCUSSION

Varietal characterization determined physicochemical, nutritional and sensorial properties of eight mango varieties. Table I, II and III: shows all these results and allowed to compare the eight varieties studied. The stones weight ranged from 22.52g to 47.6g and was maximum in *Edward*, but the percentage contribution to fruit weight by stone was minimum in this variety of 12%. With regard to other parameters, *Lipen*has the lowest values with minimum pulp weight (112.80g), pulp % (50%) and peel % (20.16%). This finding concur with the result of another author that *Lipen* variety have very low physiological weight (Rajuana *et al*., 2011).

For the biochemical properties, the Brix which indicate the level of sweeten of fruits ranged from 7.50 to 16.52 for Palmer *and Ogbomoso* respectively. The ascorbic acid which is one of the powerful natural antioxidant ranged from 12.89 mg/100g (*Ogbomoso*) to 48 mg/100g (*Edward*). The ratio of sugars to organic acids is related to flavor quality for various fruits and determines the optimum time for harvesting, because it is considered to be an index of quality. Other findings reported that the sugar to organic acid ratio isalso a major parameter of fruit taste and may be more important for quality and perceived sweetness by a sensory panel than soluble solids alone (Abeyinghe *et al*., 2007). The study show that *Ogbomoso* variety had the highest sugar to acid index of value 67.62, *Haden* 48.21 and *Edward* 44.69.

For the sensory evaluation, texture*:* It is an important quality parameter to attract the consumers. In present study, it is clear from data thatappearance of the mango dried pulp indicated the maximum texture value was recorded in *Haden* (table III). For colour, visual examination by the consumers is of significant importance that it attracts the eyes of consumer so the product colour is one of the important quality parameter. Panelists rated mango dried pulp revealed maximum value for *Haden* and lowest value for *Palmer* as shown in table III. Flavour is the sensory impression of a food or other substance and is mainly determined by the chemical sense of taste and smell. Mango variety *Haden* seemed to be highly acceptable for flavour as compare to rest of the seven varieties. The taste, is the organic acid and sugars ratio primarily creates a sense of taste which is perceived by specialized

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taste buds on the tongue. The results indicated that the taste value of mango dried pulp with the maximum in *Ogbomoso* variety and lowest in palmer variety (Table III).These results agreed with the finding of Kim et al; (2007) that *Haden*among the mangoes varieties worked upon having the best overall acceptability (Kim *et al.*, 2007). The overall acceptability test revealed that of the most acceptable mango dried pulp among the varieties was *Haden*, follow by *Ogbomoso* and the least accepted was the *Palmer* variety.

CONCLUSION:

This study investigated varietal characterization of eight mangoes in NIHORT orchard. . This study has established for each variety a physicochemical, sensory and nutritional properties fact sheet. These findings can be used both by local producers, who have now a better knowledge of the different varieties and by industrials wishing to use this raw material in their plant. Moreover, knowledge of the characteristics of mangoes in NIHORT orchard has been improved, allowing to know the best acceptable variety.

Therefore, among the eight variety, Haden, Ogbomoso and Edward have been established as the best overall acceptability. Further work to improve the processing technologies of the best mangoes into dehydrated products (e.g. dry slices, flake, bars and powders) and further into jams,marmalades, wine, juice, nectars and fruit cheese or to be had by itself or with cream as a superb dessert should be will be carry out.

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Results:

Table I: Physical properties of mango varieties

Variety	Stone weight (g)	Stone %	Pulp weight (g)	Pulp %	Peel weight (g)	Peel %
Julie	22.52 ± 1.6	13.00 ± 0.6	126.8 ± 4.5	73.00 ± 2.9	24.98 ± 1.3	14.00 ± 0.6
Haden	40.05 ± 2.1	14.00 ± 0.5	199.90 ± 5.1	74.00 ± 3.1	34.8 ± 1.8	13.00 ± 0.5
Ogbomoso	25.57 ± 1.6	15.00 ± 0.4	117.70 ± 3.7	72.00 ± 2.7	20.34 ± 1.2	13.00 ± 0.5
Lipen	27.50 ± 1.8	16.00 ± 0.6	112.80 ± 3.3	50.00 ± 2.6	20.16 ± 1.2	12.00 ± 0.5
Patch	35.22 ± 2.2	15.00 ± 0.5	184.60 ± 3.9	72 .00± 2.6	48.82 ± 2.1	13.00 ± 0.6
Palmer	31.88 ± 2.1	18.00 ± 0.7	174.00 ± 3.8	54.00 ± 2.1	46.8 ± 1.8	20.00 ± 0.8
Edward	47.60 ± 2.7	12.00 ± 0.2	289.8 ± 5.9	76 ± 2.7	52.6 ± 2.2	13.00 ± 0.4
Urlo	32.50 ± 2.1	20.00 ± 0.8	169.9 ± 3.1	58 .00± 2.1	34.67 ± 1.6	22.00 ± 0.7

Table II: Biochemical properties of mango varieties

Variety	TSS (^{O}BRIX)	Acidity (%)	Total sugar (%)	Reducing sugar (%)	Ascorbic acid (mg/100g)	Sugar/ Acid ratio
Julie	10.50± 0.2	0.41± 0.1	9.20± 1.5	2.35± 0.2	35.50± 2.5	22.44± 2.2
Haden	15.25± 0.3	0.28± 0.1	13.50± 1.7	2.79± 0.2	34.75± 2.6	48.21± 2.9
Ogbomoso	16.42± 0.3	0.21± 0.1	14.20± 1.8	2.97± 0.22	12.89± 1.6	67.62± 3.4
Lipen	9.50± 0.2	0.46± 0.0	7.18± 1.2	2.29± 0.3	26.25± 2.1	15.61± 0.9
Patch	7.50± 0.2	0.38± 0.0	5.77± 1.2	2.23± 0.3	27.20± 2.1	15.18± 1.1
Palmer	7.50± 0.2	0.42± 0.1	5.99± 1.3	2.20± 0.3	36.74± 2.6	14.26± 1.2
Edward	13.25± 0.3	0.28± 0.0	12.50± 1.4	2.66± 0.35	48.00± 2.7	44.64± 2.7
Urlo	11.17± 0.3	0.35± 0.1	9.78± 1.5	2.43± 0.31	26.00± 1.8	27.92 ± 2.3

Table III: Results of the sensory evaluation of 20 panels

Variety	Texture	Colour	Flavour	Taste	Overall acceptability
Julie	7.02 ± 0.154^{b}	7.56 ± 0.122^{b}	6.48 ± 0.188^{c}	5.85 ± 0.188^{c}	6.73 ± 0.159^{c}
Haden	7.02 ± 0.147^{b}	8.19 ± 0.133^{a}	7.29 ± 0.122^{a}	7.11 ± 0.199^{d}	7.47 ± 0.197^{a}
Ogbomoso	7.11 ± 0.155^{a}	6.66 ± 0.149^{c}	6.66 ± 0.123^{b}	7.2 ± 0.159^{a}	6.95 ± 0.179^{b}
Lipen	5.04 ± 0.143^{f}	5.76 ± 0.186^{e}	4.32 ± 0.165^{g}	3.96 ± 0.172^{e}	5.31 ± 0.132^{e}
Patch	6.3 ± 0.167^{d}	6.3 ± 0.196^{d}	5.76 ± 0.154^{d}	5.04 ± 0.151^{d}	5.90 ± 0.141^{d}
Palmer	4.68 ± 0.188^{g}	4.77 ± 0.122^{f}	4.5 ± 0.137^{f}	3.69 ± 0.160^{d}	4.43 ± 0.122^{d}
Edward	6.84 ± 0.176^{c}	6.75 ± 0.166^{c}	$7.2 \pm 0.155a^{d}$	7.02 ± 0.180^{b}	6.98 ± 0.176^{b}
Urlo	5.49 ± 0.166^{e}	6.21 ± 0.187^{d}	5.22 ± 0.132^{e}	4.05 ± 0.161^{e}	5.54 ± 0.181

Mean (±SD)having same superscript letters in a row are not significantly different at $p \leq 0.05$; (n=5)

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Evaluation of the Effect of Agricultural Crop on the Growth Performance of *Gmelina arborea* under Agroforestry System

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Abstract
Two agronomic crops (Maize and groundnut) were raised in a field experiment with Gmelina arboreawith the aim to examine the growth performance of plantation grown Gmelina under agroforestry scheme at the agroforestry plantation site of Forestry and Wildlife Management Department, Nasarawa State University Keffi, Shabu-Lafia Campus. It was laid in a3x3factorial experiment in RandomizedCompletely Block Design (RCBD). Analysis of variance was performed on the data to show the comparative performance of each treatment with another. The variables measured are: plant height, leave number, collar girth leaf length leave width and branch number. The result showed that Maize agroforestry plot recorded the highest mean value in the plant height, basal girth, number of branches, number of leaves, leave length and leaf width with mean values of 3.21±17.50, 13.92±4.29, 13.71±5.76, 92.92±56.68, 14.16±3.57 and 13.63±3.73 respectively. The result of the correlation analysis revealed that there was a significant correlation between the plant height and other assessed parameters. The result of the regression analysis on the effects of growth variables on tree plant height had coefficient of (R^2 = 0.85). From the result of the study, it is evident that agroforestry practices significantly enhances growth rate of Gmelina arborea. It is recommended that the establishment of Gmelina arborea plantation should be encouraged alongside with agroforestry activities. Also, crop rotation should be encouraged within the sapling stage of the plantation in order to maximize nutrient availability and uptake.
Keywords: Gmelina arborea, Agroforestry, Agricultural crops, plots and saplings

INTRODUCTION.

Gmelina arborea is a pioneer tree native to Asia. It was introduced to tropical Africa from South-East Asia (Ogbonnaya, *et a!.,* 1992**).** *Gmelina arborea* was introduced to Enugu, Nigeria in 1921, while an international provenance trial was established for *Gmelina arborea* are *Gmelina leacharadtii* in Enugu. The trails were assessed on the provenance during the civil was when some of the trees were harvested for bear purpose, the result of the provenance trail show that *Gmelina leacharadtii,* was not suited to Nigeria condition, *Gmelina arborea,* on the other hand, showed high adaptability and vigor, plantation of *Gmelina arborea,* has since then being spreading to other parts of the country, presently, plantation of *Gmelina arborea* mainly for timber, poles, pulps and paper production exists in many part of the country.

Gmelina arborea is a deciduous tree of the family of *verbenaceae.* It is a medium to large tree that reaches about 3 5m in height and more than 3m in diameter in natural stands in the tropical and subtropical regions of Asia (Dvorak, 2003). It lives up to 40 years, (Wikipedia, 2013). The tree is sunlight demanding, drought resistant and has a fairly good tolerance. As a result, the rapid increase in the demand of *Gmelina* based products and its other uses such as climate amelioration, soil management, and erosion control has greatly affected the total hectare age of *Gmelina* plantation in Nigeria. Hence, there is need to gently establish plantation of *Gmelina* which thrives well on moist, fertile, sandy-loath, well-Drained soil (NAFRI and DANIDA, 2000). *Gmelina* seed ripen about January to March. Thus seed are preferable best collected at this period. Seed fertility of *Gmelina* may be confirmed by throwing a small quantity into burning charcoal (without flame) and fertile one will sputter or explode which is on indication of fertile seed or seeds are soaked for 24-28 hours in water till sign of sprouting are detected in the seed. The seed are sown in beds and they geminate within 2-5 week (Adegbehin *et al.,* 1998). *Gmelina* seedlings are raised in pot or polythene bags until when the first pair of leaves has emerged. Polythene bags of 3.5 x 7 inches are suitable to raise *Gmelina arborea* seedlings (Adegbehin *et al.,* 1998).

Gmelina arborea is faced with many problem including annual bush burning over exploitation, poor seed viability and dormancy (Beet, 1 989. (The tree species faces the danger of extinction; hence, there is need for continuous attention o solve the above named problem (Agboola and Etejere, 1999; Agboola, 1995). *Gmelina* is a source of fodder, food, tannin, furniture making and gum apart from helping nutrient recycling (Etejere *et al.,* 1982; Beet 1989). *Gmelina* seeds like any other tree seed are difficult to germinate. However, the work done by (Agboola, 1995)established that *Gmelina* seed soaked in water produced high quality seedling and promote rapid germination of *Gmelina arborea* seedlings but recommended further studies involving using un drying and soaking in water and other methods, thus, there is need to intensify on his work and to find out other methods for rapid multiplication of *Gmelina* seedlings for plantation establishment particularly to examine the effect of the direct location of seed source and examine the effect of different pretreatment on the seedlings germination and growth rate.

Gmelina arborea is reasonable strong for its weight. It is used for a great variety of purposes including furniture and light constructions. It is also used for veneers and plywood, particles board matches and as a major source of raw: material for pulp paper making carriages, sports, musical instrument and artificial limbs, once seasoned it become a very steady timber and moderate resistance to decay and also ranges from very resistant to moderately resistant to termites. The leaves are considered good as fodders for cattle (Crude of about 11.9%) its root and bark are to improve appetite; useful in hallucination, fever and abdominal pains (Duke, 1983). The leaf paste when apply, relieve headache and its juice is used to cure ulcer. It flowers are sweet, cooling and bitter; they are useful in curing leprosy and blood disease. The plant is recommended in combination with other drugs for the treatment of snakebites and scorpion stings. In snakes, a concoction of the root and bark is given internally (Wikipedia, 2013).

Concept of agroforestry

As a management practices: Agroforestry can be defined as a group of land management techniques combining forest trees with crops, with or without domestic animals. The combination may be either simultaneous or staggered in time and space with the sole objective of optimizing production while ensuring proper management of the farmer`s land for optimal multiple use production and sustainability of production (yield of tree crop and food crop) within the system. Agroforestry as a science has developed out of the need to protect the resource poor farmer, ensure less deforestation and environmental degradation while still producing on a sustainable basis. According to Ayodele *et al* (1999) these issues had created problems in the land use system of a larger part of the tropics and alternative production approaches that would be acceptable to the people, improve production on a sustainable basis and allow for multiple land use needed to be developed. These reasons had led to the necessity for research into this age-long technology with the establishment of the International Centre for Research in Agro-forestry (ICRAF) as a Council in 1992 and now called the "World Agroforestry Centre" (WAC) the following have been identified as the Advantage of

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Agroforestry Technology: The tree component controls run off and erosion there by reducing losses of water, soil material, organic matter and nutrient availability for both tree and agricultural crops. Agroforestry system helps in maintaining favourable soil physical properties than Agriculture through organic matter maintenance and the effect of the roots. It reduces the prevalence of insects and other pest and moderates microclimate. Furthermore, tree components of Agroforestry help in maintenance or increase of soil organic matter and trees fix nitrogen and make it available to companion crop. The system serves to protect the crops, and top soil from the impact of sun and rain the system also provides cash for the farmers with different produce and allows the optimal use of piece of land for production of variety of goods and services.

The increasing demand for *Gmelina arborea* by a greater majority of people for timber, pulp and other purposes in the world today makes it necessary to find a way of increasing it yield through proper management and adopting best this is because the poor management culture of Nigeria forest has led to poor yield and multiplication of timber product in view of the potentials of *Gmelina arbores*, the rate at which the tree species is being felled for forage, commercial and other purpose is too high whereas the regeneration and afforestation of the tree species is virtually nothing to write home about as there is an annual decline in the rate of plantation establishment of *Gmelina arborea* in Nigeria. There is therefore need to find a suitable solution to this problem of scarcity of this species of timber and at the same time increase food production.

MATERIALS AND METHODS

The experiment was carried out at the agroforestry plot of the Department of Forestry and Wildlife Faculty of Agriculture, Nasarawa State University Keffi, Shabu- Lafia Campus. Lafia, (08^0 $35'^N$, 08^0 $33'^E$), located in the Guinea Savannah zone of North Central Nigeria at an altitude of about 177m above sea level. The mean monthly maximum temperature, relative humidity and rainfall are 28.03^{0C}, 74.67% and 168.90mm respectively (Jayeoba, 2013). The seeds of these crops were planted directly alongside with *Gmelina arborea* after 62 weeks of establishment. Germination of the different crops varies according to species ranging from 4 days in Maize and 5 days in Ground-nut. Ridges were prepared in the plantation for sowing the crops. As the plant grows on different plot of the plantation, data were collected on the *Gmelina arborea* stands in the plantation (Plate 1-4). The growth parameters assessed include. Plant height (cm); Leaf width (cm); Basal girth (cm); Leave area (m^2) Leave length (cm): and Branches: The experiment was three factor and randomly assigned into 3 different treatments at level 1, (Maize) 2 (Ground-nut) and 3 (Control). Data was collected through field observation and recording performed by noticing the growth performance of the crops (Maize, and groudnut) under *Gmelina arborea* plantations and the influence of each of the planted crops on the growth of *Gmelina arborea* saplings.This Agro-forestry practice was carried out during early raining season starting from March to July 2018. The study was laid out in 3x3factorial experiment in a Randomized Completely Block Design (RCBD) as described by (Akindele, 2004; Adesoye, 2004). Analysis of variance was performed on the data to show the comparative performance of each treatment with another. The Data collected was subjected to mean and Analysis of variance (ANOVA) and significant mean differences were separated at 0.05 probability level as described by Steel *et al*. (1997).Correlation analysis was used to

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establish the relationship between the growths parameters 3 different plots.

			
Plate 1: measurement of plant height	Plate 2: Manual Weeding	Plate 3: *Gmelina* intercropped with Maize	Plate 4: *Gmelina* intercropped with Groundnut

RESULTS

The mean values of growth parameters measured on Gmelina Agroforestry plots is shown on shows that Table 1.Maize agroforestry plot recorded the highest mean plant height of 3.96±0.50m, followed by plot 2 G,nut agroforestry site with mean value of 3.21±0.50cm, while Plot 3 (control site) recorded the least mean plant height value with 2.37±0.27m.The result of mean Basal girth showed that, Plot 1 recorded the highest mean basal girth (13.92±4.29cm), closely followed by plot 2 with mean value of 13.67±4.66 cm, while plot 3 again recorded the least mean value of 7.36±2.08cm. The mean values of Numbers of Branches showed that, plot 1 recorded the highest mean value of 13.71±5.76cm, followed by plot 2 with mean value of 10.13±6.08cm, while plot 3 again recorded the least mean value of 4.34±2.40cm. The mean values for Numbers of leaves showed that, plot 1 again has the highest numbers of leaves with 92.92±56.68cm, followed by plot 2 with mean value of 82.13±56.67cm, while plot 3 recorded the least mean value of 33.88±25.23cm. The mean values for Leaf length showed that, plot 1 recorded the highest Leaf length of 14.16±3.57cm, followed by plot 2 with the mean value of 12.03±3.69cm, while plot 3 recorded the least mean value of 7.81±4.75cm. The mean values for Leaf width showed that, plot 1 recorded the highest Leaf width mean value of 13.63±3.73cm, followed by plot 2 with mean value of 12.38±4.33cm, while plot 3 recorded the least mean value of 8.78±5.46cm. (Table 1)

The mean values of growth parameters measured on the basis of month shows that the highest mean plant height value (2.66±14.68cm) was recorded after 28months of establishment, followed by 2.65±12.89cm in the 30th month of the establishment, while month 26 recorded the least mean plant height value of 1.62±0.55cm. The highest basal girth value was recorded in month 28 and 30 with mean value of 12.58±4.89cm respectively, while week 22 again recorded the least mean value of 10.66±4.74cm. The highest mean values of Numbers of Branches (12.15±5.91) was again recorded in the 30th month, followed by 28th month with 9.88±6.17, while 26th month recorded the least mean value of 6.62±5.62. The mean values for Numbers of leaves showed the same trend with 93.52±51.11 in the 30th month, 66.65±40.03 in the 28th month and 38.67±41.64 in the 26th month also in Leaf length 14.47±2.79cm, 11.32±3.63cm and 8.33±4.90cm respectively and Leaf width 15.88cm±2.35, 12.39±2.60cm and 6.90±4.38cm (Table 1).

The result of the correlation analysis revealed that there was a significant correlation between plant height and other growth variables assessed (Table 2). The result of the regression analysis on the effects of growth variables on tree plant height had coefficient of (R^2 = 0.85) (Table 3) meaning that the assessed growth variables had about 85.0% effects

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on plant height of *Gmelina arborea* intercropped with maize and groundnut on the agroforestry plot

DISCUSSION

The study considered the interaction of *Gmelina arborea* (Roxb) with selected agricultural crops in an agro-forestry practice. From the result, planting of agro-plants had a positive effect on the growth of the assessed variable. The result showed that the saplings of *Gmelina arborea* where only maize was planted recorded the highest mean value of the growth parameters with 3.96±0.54cm in plant height. 13.92±4.29cm in Basal girth, 13.71±5.76 in branches production. Leaf length had a mean value of 14.16±3.57cm, while Leaf width had 13.63±3.73cm. Although, the result was contrary to the study carried out by Egbewole *et al* (2017) on Gmelina in an agro-forestry practice where he reported Maize agro-forestry plot to be the least performed to okra and groundnut. But in accordance with the research of Tewari (1995), who reported that planting *G. arborea* with crops like maize to be beneficial in increasing the simultaneous production of timber and food crops. This result could be due to the fact that ground nut was planted on the same plot in the previous planting season making available enough nitrogen on the same plot for maize uptake in the present season. Plot 2 where groundnut was planted recorded the highest the second best in all respect. This result is in line with Egbewole *et al* (2017) in a similar study on the fast growth of *Gmelina* under agroforestry practice. The fingings also agreed with Feldhake, *et al* (2008) who noted that forages under trees experienced essentially shaded conditions when the flush of spring growth occurred and with Egbewole *et al*, (2015) on the assessment of germination and early growth trial of *Gmelina arborea.* Feldhake (2001) again found that surface soil temperatures during dry periods could affect growth and yield of forest tree; he further observed that soil moisture was slightly lower under trees than in the alley centres. Nutrient uptake was significantly correlated with shoot dry weight (Baligar *et al*, 2001). On a general note agronomic plant has a positive effect in the growth of *Gmelina arborea*.

The continuous growth noticed as at the period of data collection could be attributed to the fact the *Gmelina* stands is still at the sapling stage hence, growing at rapid rate. This is in accordance with the report of Rotowa *et al* (2017) on *Moringa olifera* and Baligar *et al* (2008) reported that the uptake of all the macronutrients was significantly influenced by species, with time in a study he carried out at Beltsville Agricultural Research Centre, Beltsville, Maryland, in South America. Variations in nutrients uptake were related to differences in dry matter accumulation between species. Nine cover crop species tested in this experiment expressed significantly different in growth parameters and nutrient uptake, influx, transport, and utilization efficiency at difference time on different tree crop in a study by Baligar *et al* (1997) Hence, it is possible to select cover crop species, which may be suitable for different plantation crops with varying amounts of shade in improving soil fertility and conserving soil and water resources for maximum growth of root, shoot, relative growth rate, and net assimilation rate, uptake of plantation species.

CONCLUSION AND RECOMMENDATION

It is evident from this investigation that agroforestry practices significantly enhances growth and development of *Gmelina arborea.* It was discovered from the result that maize planted under *Gmelina* has significantly influences the saplings height because groundnut was planted on the same plot in the previous planting season thus fixed nitrogen in the soil. Base on the result of the study, It is

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recommend that proper silvicultural activities should be given to the *Gmelina* stands intercropped with cover crops under agroforestry practice, establishmentof *Gmelina arborea* plantation should be encouraged alongside with agroforestry activities. Also, crop rotation should be encouraged within the sapling stage of the plantation in order to maximize nutrient availability and usage. Further and more comprehensive study in this area is recommended especially on other agricultural crops.

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Table 1: Mean value and Duncan mean separation value for growth variables of *Gmelina arborea* on the basis of Agro-plant and Duration.

S/N	Source of Variation	Sample size	Plant Height (m)	Basal girth (cm)	No. of Branches	No. of Leaves	Leaf length (cm)	Leaf width (cm)
	Plant							
1.	Maize	100	3.96±0.546[a]	13.92±4.29[a]	13.71±5.76[a]	92.92±56.68[a]	14.16±3.57[a]	13.63±3.73[a]
2.	Groundnut	100	3.21±17.50[a]	13.67±4.66[b]	10.13±6.08[b]	82.13±56.67[b]	12.03±3.69[b]	12.38±4.33[b]
3.	Control	100	2.37±0.27[a]	7.36±2.08[b]	4.34±2.40[c]	33.88±25.23[c]	7.81±4.75[c]	8.78±5.46[c]
	General mean	300	2.18±6.10	11.65±3.68	9.39±4.75	69.64±46.19	11.33±8.24	11.59±4.56
	Duration							
1.	26 month	100	1.62±0.55[a]	10.66±4.74[a]	6.62±5.62[a]	38.67±41.64[a]	8.33±4.90[a]	6.90±4.38[a]
2.	28 month	100	2.66±14.68[a]	12.58±4.89[b]	9.88±6.17[b]	66.65±40.03[b]	11.32±3.63[b]	12.39±2.60[b]
3.	30 month	100	2.65±12.89[a]	12.58±4.89[b]	12.15±5.91[c]	93.52±51.11[c]	14.74±2.79[c]	15.88±2.35[c]
	General Mean	300	2.31±9.37	11.94±4.84	9.55±7.97	83.44±44.26	11.46±3.77	11.72±3.11

Note: Figures with the same alphabet in the same column are not significantly different at $p<0.05$

Table 2: Correlation analysis for parameters assessed

	Num. of Branches	Leaf length	Leaf width	Basal girth	Number of Leave	Plant height
Num. of Branches	1.000					
Lea length	0.729**	1.000				
Leaf width	0.687**	.850**	1.000			
Basal girth	0.708**	0.574**	0.516**	1.000		
Number of Leave	.831**	0.755**	0.767**	0.659**	1.000	
Plant height	0.681**	0.588**	0.529**	0.736**	0.659**	1.000

****= correlation is significant at 5% level p< 0.01, *= correlation is significant at 5% level p<0.05**

Table 3: Regression Analysisfor Parameters Assessed

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
	B	Std. Error	Beta			R^2
(Constant)	0.724	1.226		0.590	0.555	
Basal girth	0.162	0.112	0.070	1.437	0.151	
Leave Number	0.005	0.013	0.023	0.369	0.712	
Num. of Branches	0.193	0.114	0.108	1.682	0.093	
Leaf length	-.432	0.183	-.180	-2.369	0.018	
Leaf width	0.208	0.170	0.090	1.223	0.222	0.85

Note: **= highly significant at at p<0.05, * = significant at p<0.05, ns = not significant

Dependent Variable: Height.

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In Vitro Gas Production of Ensiled Guinea Grass-*Albizia saman* Pods Silage

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Abstract
Meeting nutritional requirement of ruminants during dry season is challenged due to low quality forage. This necessitates use of unconventional feedstuff. Horticultural waste, rich in nutrients ensiled with grass species provides efficient rumen environment for microbes to thrive and ferment feeds thereby increasing productivity of animals. Pods from Albizia saman tree; an ornamental plant used for landscaping is usually wasted in large volumes in Southwestern Nigeria. Thus, dry Albizia saman pods and Guinea grass cut at six weeks old were assigned into treatments in ratio (10:90), 20:80, 30:70 and 40:60 and ensiled using standard method. Gas production was recorded at 3, 6, 9, 12, 15, 18, 21, 24, 36 and 48 hr of incubation. In vitro gas characteristic and in vitro gas parameter; Organic matter Digestibility OMD), Short Chain Fatty Acid (SCFA) Metabolizable Energy (ME) and Gas Volume (GV) were determined for each silage using in vitro gas technique. Data were analysed using descriptive statistics and ANOVA at $p<_{0.05}$. There was no significant difference in GV, ME, OMD and SCFA. In vitro gas characteristic followed the same trend at 24 hr of incubation. At 36hr of incubation 40% Albizia saman pod inclusion silage had least value of gas produced(13.67 mL), insoluble but degradable fraction (28.10mL^3) and rate of gas production 'c' (0.027 mLh^{-1}). The 'c' was highest in 20% at 48 hr of incubation. All Albizia saman pod silages present quality feed. Thus, Albizia saman pod should be put to productive use; as silage for ruminant feed.
Keywords: *ruminant, feed conservation, horticultural waste, forage, dry season feeding, rumen fermentation*

INTRODUCTION

Livestock feeding is of great concern to livestock farmers especially in the critical dry season when all forage are dried, lignified and thequality of forage mass available for animal consumption is depleted (Jetana*et al.,* 2010). Supplementation of this forage with legume feed source help the animals to achieve optimal performance of the expected metabolic activitiestowards increasedproductivity.*Albizia saman,*a leguminous tree also known as rain tree is grown as an ornamental shade tree whichbesides the aesthetic value, at the University of Ibadan Nigeria, more than two hundred well grown trees are planted to cast shade along the walk way. Also, in villages where elder sit under it for relaxation in the evening. It also yield large volume dark brown and leathery pods, the pods are valuable supplements to goats and other ruminants(Stewart and Dunsdon, 2000; Jetana*et al.*, 2010) who cherish it, as they naturally pick it up after dropping from the tree (Jolaosho*et al.*, 2006). Ruminants relish the pods that drop from the tree at the University of Ibadan, Nigeria (Otukoya, 2007). She also, reported that the seeds in thepods are hard and indigestible when eaten raw by ruminantshowever, the hard coat can be broken through anaerobic fermentation toallow animals access the nutrients.In Nigeria therearefodder trees, seeds and podswith valuable nutrient composition (Aribido, 2010) that can replace conventional feedthereby eliminating competition between humans and animals.
With increasing demand for livestock products as a result of rapid growth in the world economies and shrinking land area future hopes of feeding ruminant animals is a challenge. Safeguarding their food security will depend on the better utilization of unconventional feed resources which do not compete with human food.This therefore necessitates

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research into available and affordable but, unconventional feedstuffs the first step of which is determining their nutrient qualities. *In vitro* gas production gives a quick, predictable response of feed with little financial implicationin assessing the feed quality. (Babayemi and Bamikole, 2006). Therefore the study was conducted to assessthe quality of ensiled Guinea grass-*Albizia saman*pods using *in vitro* gas production techniques.

MATERIALS AND METHODS

Four bunker silos each were used to prepare the ensiled feedstuffs with different graded level grass and *Albizia saman* pod in the dairy farm of the Teaching and research Farm, University of Ibadan, Nigeria. *Albizia saman* pods (ASP) were gathered and sun dried. Guinea grass (GG) was harvested at 6 weeks old when the nutritive value was high and witted for 12 hours. The Guinea grass was chopped into 25 cm length to ease parking and consolidation for ensiling.Ratio of*Albizia saman* pod to Guinea grass was weighed according to the graded level of four treatments as 10% ASP + 90% GG, 20% ASP + 80% GG, 30% ASP + 70% GG, 40% ASP + 60% GG. 0.2% salt was added in layers to improve palatability. The silage was compacted tightly at intervals such that finger cannot easily penetrate into it. The silo was covered quickly because the bucker was lined with thick polythene folded and tucked invery well to make it air tight. Heavy sand bags were put on each silo to ensure airtight and maximum compaction. The silage was made to ferment for 40 days under anaerobic condition

In vitro techniques

Rumen fluid was obtained with suction tube technique from three West African dwarf goatspreviously fed with 40% concentrate feed (40% corn, 10% wheat offal, 10% palm kernel cake, 20% groundnut cake, 5% soybean meal, 10% dried brewers grain, 1% common salt, 3.75% oyster shell and 0.25% fish meal) and 60% *Panicum maximum* at 5% of body weight as described by Babayemi and Bamikole, (2006).The rumen liquor was kept in pre-warmedthermo flask at 39ºC. Incubation procedure was carried out according to Menke and Steingass (1988) using 120 ml calibrated transparent plastic syringes with fitted silicon tube. 200mg of each sample in triplicate were carefully inserted into the syringes and 30 ml inoculums containing cheese cloth strained rumen liquor and buffer solution (g/liter) (9.8 $NaHCO_3$ + 2.77 Na_2HPO_4 + 0.57 KCl + 0.47 NaCl + 2.16 $MgSO_4.7H_2O$ + 0.16 $CaCl_2.2H_2O$) (1:4 v/v) under continuous flushing with CO_2 and dispensed with 50 ml plastic calibrated syringe. Complete elimination of air in the inoculum was done by tapping and pushing upward the piston followed bytightening the silicon tube using metal clip to prevent the escape of gas. Incubation was carried out at 39 ± 1ºC and the volume of gas production was measured at 6 hour intervals: 0, 6, 12, 18, 24, 36 and 48 h. Post incubation4 ml of NaOH (10 M) was introduced to estimate methane production (Fievez*et al*., 2005). Then parameters such as Metabolisable Energy (ME), Organic Matter Digestibility (OMD) and Short Chain Fatty acids (SCFA) were estimated at 24 h post gas incubation (Menke and Steingass, 1988). The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample.

The volume of gas produced at intervals was plotted against the incubation time, and from the graph, the gas production characteristics were estimated using the equation $y = a + b\ (1 - e^{-ct})$ as described by Ørskov and McDonald (1979). Where y = volume of gas produced at time 't', a = intercept (gas produced from the soluble fraction), b = gas production from the insoluble fraction

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c = gas production rate constant for the insoluble fraction (b), t = incubation time.

ME (MJ/Kg DM) = 2.20 + 0.136 GV + 0.057 CP + 0.0029 CF (Menke and Steingass, 1988).

OMD (%) = 14.88 + 0.889 GV + 0.45 CP + 0.651 XA (Menke and Steingass, 1988).

(SCFA) (µmol) = 0.0239 GV – 0.0601 (Getachew*et al*., 1999). Where GV, CP, CF and XA are total gas volume at 24hr, crude protein, crude fibre and ash respectively. Data were analysed usingdescriptive analysis and analysis of variance at $p<0.05$ (SAS, 1999).

RESULTS AND DISCUSSION

Gas production parameters

Quality feed is of great importance in livestock production especially in dry season, it has implication on small ruminant subsector of agricultural sector in the nation economy (Ososanya *et al*., 2013).Gas produced during fermentation of nutrients in the rumen is a nutritionally wasteful product, but provides a useful basis from which Metabolizable Energy (ME), Organic Matter Digestibility (OMD) and Short Chain Fatty Acids (SCFA) could be estimated. 40% Inclusion of *Albizia saman* pod silage had the highest gas production (24.76 mL^3) this leads to high ME (6.60 MJ/KgDm), OMD (51.20%) and SCFA (0.49µmol). Rate of gas production in figure 1 is proportional to quantity of *Albizia saman* pod inclusion from 3 to 24 hours except for the treatment with 20% *Albizia saman* pod inclusion silage which produced gas lower than 10% inclusion of *Albizia saman* pods inclusion silage. The relatively low rate of gas production at 20% inclusion level is reflected in the low gas production parameters.At 24hrs, the level of degradability by the microbes is always a function of the *in-vitro* gas characteristics where 'b' the degradable fraction is least in 20% and highest degradable fraction is seen in 40% *Albizia saman* pod inclusion.The rate of degradation of substrate which is proportional to gas production in this study increasedwith *Albizia saman* pod inclusion except in 20% inclusion.

At 36hrs and 48hrs incubation, 30% inclusion produced highest gas volume from fig.2 this was followed by 10% inclusion. This might be due to depletion of degradable fraction of the substrate in the 40% *Albizia saman* pod inclusion overtime.At 36 and 48hrs of incubation the level of degradable fraction has been depleted while treatment with lower ASP inclusion and lower degradation are getting degraded with time.High production of gas from 40% inclusion of *Albizia saman*pod infers an increased proportion of acetate and butyrate but decrease in propionate production (Babayemi*et al.,* 2004). Acetate and butyrate are lipogenic, which leads to synthesis of butter fat in milk while propionate is glucogenic which leads to production of lean meat. Therefore, inclusion of *Albizia saman* in ruminant diet can be incorporated into silage for lean meat production

40% inclusion of *Albizia saman*pod silage had the highest gas volume hence the highest SCFA. The lowest gas volumes and SCFA were observed in 20% inclusion of *Albizia saman*. Also, gas production helps to measure digestion rate of soluble and insoluble fractions of feedstuff. Energy supplement produces higher gas compared to protein supplement and that protein fermentation does not lead to much gas production (Gatechew *et al.,* 1998). This could be responsible for lower gas production observed from the 20% inclusion of *Albizia saman*pod silage.

Gas production was directly proportional to SCFA (Babayemi and Bamikole, 2006), the higher the gas produced the higher the SCFA.SCFA level indicate the energy available to the animal, it contributes nearly 80% of animal daily energy requirement (Fellner, 2004). There is a direct relationship between SCFA

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andmetabolizable energy (ME). Hence, 40% inclusion of *Albizia saman*pod silage with highest gas production had highest SCFA and OMD. While the 20% inclusion of *Albizia saman*pods silage with the lowest gas volume had the lowest SCFA, ME and OMD.

SCFA measurement is very important for relating feed composition to production parameters and to net energy value of the silages, therefore production of SCFA from *in vitro* gas measurement will be increasingly important in a developing country like Nigeria. Nitiport and Sommart (2003); Kenneth-Obosi and Babayemi, (2013); Saliu and Ososanya (2017) all reported direct relationship between OMD and gas production. The quality of gas produced by ruminant during fermentation is a reflection of the amount of substrate degraded and the microbial metabolic activity (Kenneth-Obosi and Babayemi, 2013).

Table 3 shows the intercept value (a) for all silages ranged from 4.00mL^3 in 10% silage at 24 hours to 10.67mL^3 in 40% silage at 48 hours. The value of 'a' increases as the time of fermentation increases.It also increases as the level of inclusion of*Albizia saman* pod increases at each incubation period. Therefore, ensiling has softened the pod and seeds (Kenneth-Obosi *et al*., 2017), this increase the soluble fraction of the feed. The value for absolute 'a' used ideally reflects the fermentation of the soluble fraction in this study.The absolute gas production was highest for 40% silages at 48hr.This soluble fraction was found to be highest at this level (40% silage at 48hr).The soluble fraction makes it easily attachable by ruminal microorganism and leads to much gas production. Therefore, more ruminant microorganisms worked on the 40% *Albizia saman*pod inclusion and this leads to the highest gas production observed. The soluble fraction decreases as level of *Albizia saman* pod inclusion and incubation time increases.

The extent of gas production 'b' described the fermentation of the insoluble fraction. The gas volume of 20% inclusion of *Albizia saman*pod at 24hr (Table 1) had the lowest value of 18.00 mL^3 and was highest in the 10% *Albizia saman* pod inclusion *Albizia saman*at 48hr (Table 3). The value of 'b' increases as the incubation period increases.The 'b' predicts feed intake. Blummel and Orskov (1993) found that the 'b' value could account for 88% for thevariation in feed intake. The rate of gas production 'c' was lowest in 10% inclusion of *Albizia saman* pod silage at 48hr and highest in 40% inclusion of *Albizia saman* pod silage at 24hr (Table 1).

The rate of gas production increases as the time of incubation increases. The high value of the rate of gas production in 40% silage at 24hr(Table1) is possibly influenced by the carbohydrates fractions readily available to the microbial population. At 36hr(Table 2) and 48hr(Table 3) incubation period, the value of 'c' that had been increasing with level of inclusion of *Albizia saman* pod started decreasing at 30% inclusion of*Albizia saman* pod. This might be as a result carbohydrate fraction depletion which affected the kinetics of gas production. Kenneth-Obosi and Babayemi, (2015) indicated that the intake of feed is mostly explained by the rate of gas production which affects the rate of passage of the feed through the rumen.

High rate of gas production and extent of gas production were observed in 40% inclusion *Albizia saman* pod silage at 24 hours due to low fibre contents while low rate and extent of gas production were observed in 20% *Albizia saman* pod silageat 24hours due to high fibre contents.These findings were in agreement with the above reports.

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The soluble fraction 'a' increasedas the level of *Albizia saman pods*increases in the incubated silages in Tables 1, 2 & 3.Thisis an indication of the solubility of the*Albizia saman* pod compared to the high lignin content found in guinea grass (Chumpawadee and Pimpa, 2009). The structure of carbohydrate and protein in the diet determines the rate and extent of degradability. There was no significant difference in the degradability by the microbes in ('b') the degradable fraction of the silage.Microbial population in the rumen was supported by high crude protein content foundin the *Albizia saman* pod silage which determines the level of fermentation (Babayemi*et al*., 2010).

The Metabolizable Energy (ME), Organic Matter Digstibility (OMD) and Short Chain Fatty Acid (SCFA) values are higher (5.33, 40.42 and 0.36respectively.100% *Albizia saman* pod ensiled andfed to ruminant modified the rumen ecology, influence fermentation and increase animal performance contained secondary metabolites like tannins, saponin and essential oils (Babayemi *et al*., 2010; Gunun*et al*., 2018). The combination of Guinea grass and ASP produced higher gas at 24hr compared with gas production from *in vitro* fermentation of cassava top and maize stover ensiled with *Albizia saman* pod (Saliuand Ososanya, 2017). Hence, farmer can utilise abundant Guinea grass slashed off as weed and ensiled it with pods from *Albizia saman*trees found in different part of the country

The insoluble but degradable fraction 'b' and rate of degradation 'c' increased with increase in ASP in the silage at 24hr except at 20% ASP (Table 1) this agrees with the findings of Saliu and Ososanya, 2017. Although not significantly different but it can be inferred ensiling has softened the pod and the seed coat which makes degradation by the microbes possible compared favourably with silage with higher grass ratio. (Otukoya,2007). Rate of gas production which peaked at 36 hours and 48 hours in 20% inclusion maintained the same rate in 30% but declined in 40% inclusion of *Albizia saman* pod while at 48hours it starts to decline from 30% inclusion. Low (a+ b) recorded in 40% inclusion at 36hours was probably due to their high protein content, Khazaal*et al.,* 1995 reported that protein fermentation does not lead to much gas production. The peak rate of degradation 'c' for 40% ASP was achieved at 24hr and begins to decline as time progress this may be related to ability of the microbes to access the 'b' fraction in the pod compared to the treatment having higher percentage of Guinea grass

CONCLUSION

The result showed that 40% inclusion level of*Albizia saman* pod recorded highest gas volume, ME, OMD and SCFA which is a measure of digestion rate of soluble and insoluble fractions of the silages. Thus, more substrates are degraded at this inclusion level.10% inclusion level of *Albizia saman* pod had lowest gas volume, ME, ODM and SCFA which inferred that less substrate were degraded. Thus, *Ablizia saman* pod a waste that constitute nuisance to the environment can be put to use up to 40% inclusion guinea grass based silage for better performance animal and cleaner environment.

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Table 1: ***In vitro* fermentation parameters of graded levels of *Albizia saman* pod silages**
Levels of *Albizia saman* pod (ASP) inclusion

Parameters	Treatment				
	10% ASP + 90% GG	20% ASP + 80% GG	30% ASP + 70% GG	40% ASP + 60% GG	SEM
Metebolizable energy (MJ/Kg DM)	6.06	5.65	6.36	6.60	0.60
Organic Matter Digestibility (%)	50.50	47.60	50.78	51.20	4.02
Short Chain Fatty Acid(µmol)	0.47	0.37	0.49	0.53	0.11
Gas Volume (mL^3)	21.67	18.00	23.00	24.76	4.42

SEM: Standard Error of Mean, ASP: *Albizia saman* Pod; GG; Guinea Grass

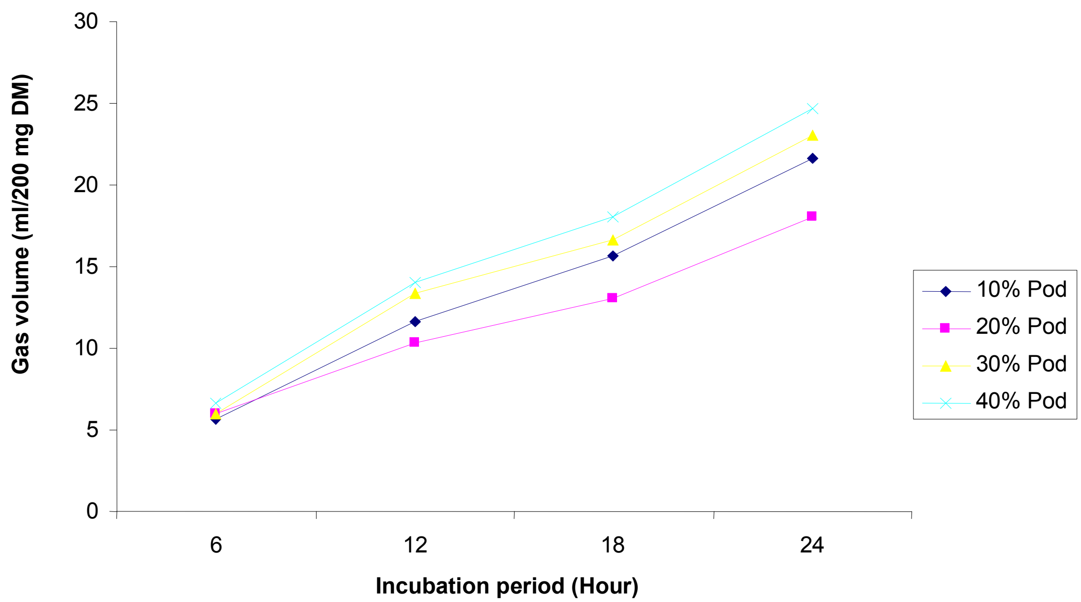

Figure 1. *In vitro* gas production of ensiled *Albizia saman* pod with Guinea grass

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Table 2: *In vitro* fermentation characteristics of graded level *Albizia saman* silages for 24 hours

Production feature	Treatment				
	10% ASP + 90% GG	20% ASP + 80% GG	30% ASP + 70% GG	40% ASP + 60% GG	SEM
a (mL^3)	4.00	6.00	6.00	6.67	0.51
a+b (mL^3)	21.67	18.00	22.33	24.76	4.42
b (mL^3)	17.67	12.00	16.33	21.33	4.33
c(mLh^{-1})	0.053	0.050	0.060	0.067	0.006
y(hrs)	13.33	11.67	15.00	15.67	1.16
t(hrs)	14.00	14.00	14.00	14.00	.60

a = zero time intercept which ideally reflects the fermentation of soluble fraction; b = extent of gas production/insoluble but degradable fraction ;(a+b) =potential extent of gas production; C = rate of gas production; y= volume of gas produce at time (t).; t = Incubation time; SEM= standard error of means

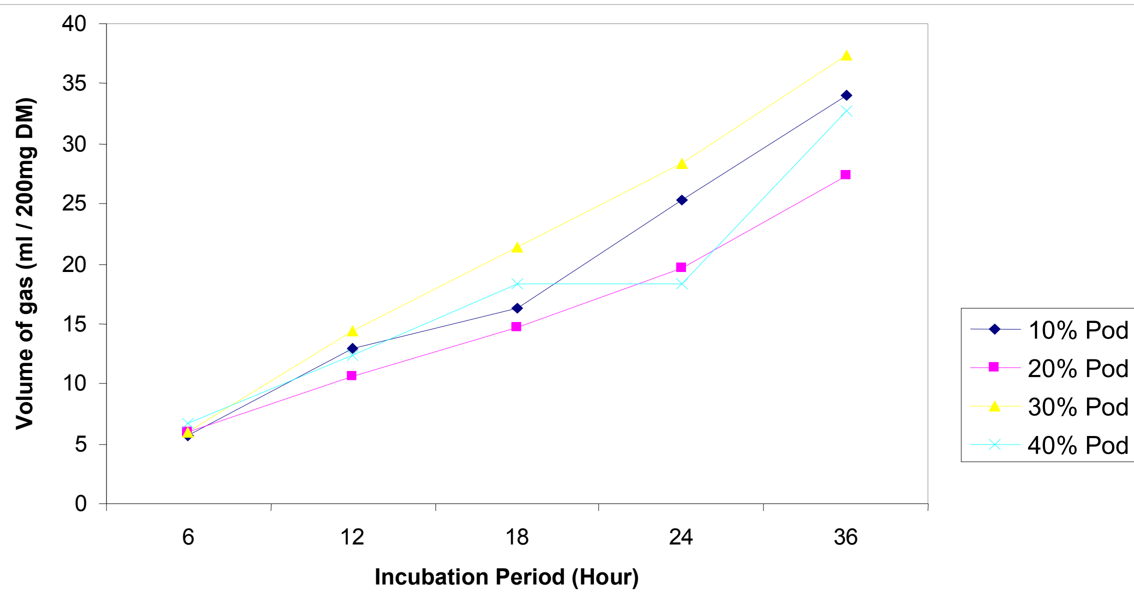

Figure 2. *In vitro* gas production of ensiled *Albizia saman* pod with Guinea grass for 36 Hours

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Table 3:*In vitro* fermentation characteristics of graded level *Albizia saman* pod silages (36 hours)

Production feature	Treatment				
	10% ASP + 90% GG	20% ASP + 80% GG	30% ASP + 70% GG	40% ASP + 60% GG	SEM
a (mL^3)	5.67	6.00	5.67	6.67	0.37
a+b (mL^3)	34.00	37.33	37.33	32.67	6.35
b (mL^3)	28.33	31.33	31.67	28.00	6.32
c(mLh^{-1})	0.033	0.037	0.037	0.027	0.004
y (hrs)	16.00	18.33	18.33	13.67	2.12
t (hrs)	16.00	16.00	16.00	16.00	1.53

a = zero time intercept which ideally reflects the fermentation of soluble fraction; b = extent of gas production/insoluble but degradable fraction ;(a+b) =potential extent of gas production; C = rate of gas production; y= volume of gas produce at time (t).; t = Incubation time; SEM= standard error of means

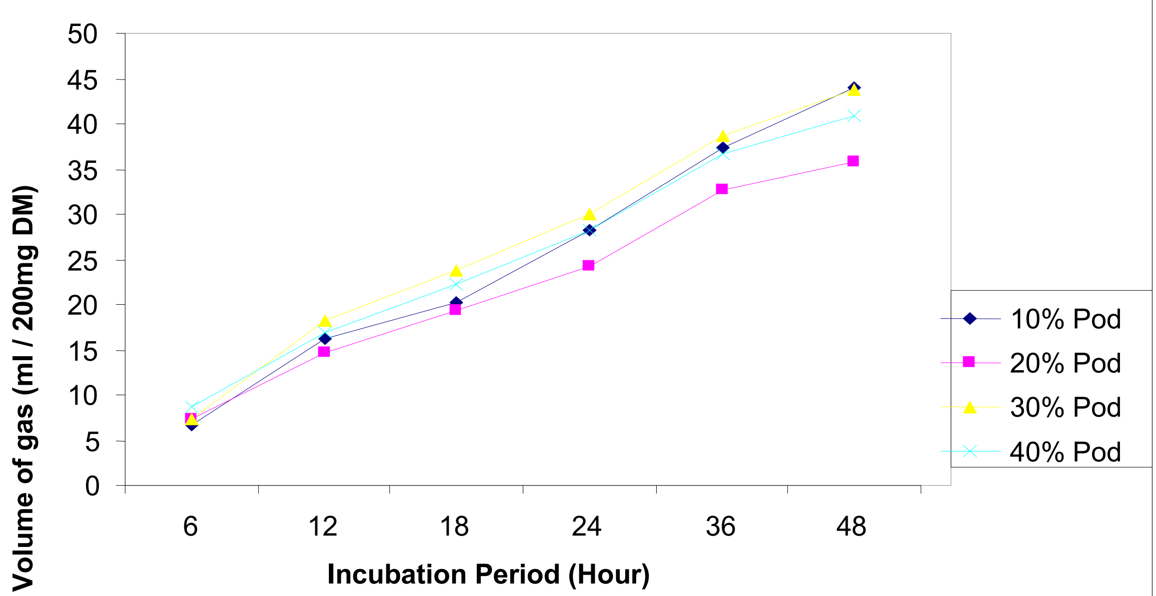

Fig. 3 *In vitro* gas production of ensiled *Albizia saman* pod with Guinea grass for 48 h

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Table 4: *In vitro* fermentation characteristics of graded level *Albizia saman* silages for 48 h

Production feature	Treatment				
	10% ASP + 90% GG	20% ASP + 80% GG	30% ASP + 70% GG	40% ASP + 60% GG	SEM
a (mL^3)	6.67	7.33	7.33	10.67	0.79
a+b (mL^3)	44.00	35.67	43.67	41.00	6.57
b (mL^3)	37.33	28.33	35.33	30.33	6.91
c(mLh^{-1})	0.023	0.037	0.030	0.027	0.003
y(hrs)	16.33	18.67	18.33	21.00	1.93
t(hrs)	12.00	18.00	12.00	18.00	1.41

a = zero time intercept which ideally reflects the fermentation of soluble fraction; b = extent of gas production/insoluble but degradable fraction ;(a+b) =potential extent of gas production; C = rate of gas production; y= volume of gas produce at time (t).; t = Incubation time; SEM= standard error of means

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Effect of Stem Maturation on Rooting Ability of Five Hedge Plants

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Abstract
A nursery experiment was conducted to investigate the effect of stem maturation on the rooting ability of Breynia nivosa, Duranta repens, Gardenia jasminoides, Ixora coccinea and Mussaendra erythrophylla. The main objective was to evaluate the effects of apical, sub-apical and basal cuttings of the 5 hedges on percentage rooting. A completely randomized design was used with 20 cuttings per subplot replicated three times per species. The cuttings as treatments were set in germination boxes filled with washed and sterilized sharp sand and placed in the green house. The cuttings were assessed after 10 weeks for mean percentage rooting of the five species. Descriptive statistics using means and percentage were used in data analysis. Results showed that there were significant differences in percentage rooting between the apical, subapical and basal cuttings of the species at 5% level of probability. D. repens had percentage rooting of apical sub-apical and basal cuttings as 100%, 56% and 9% respectively. B.nivosa had percentage rooting for apical, sub-apical and basal cuttings as 52%, 10% and 0% respectively. G. jasminoides had percentage rooting for apical sub-apical and basal cuttings as 92%, 94% and 68% respectively. I. coccinea had percentage rooting for apical, sub-apical and basal cuttings as 100%, 100% and 55% respectively while M. erythrophylla had 100% for apical cuttings, 56% for sub-apical and 10% for basal cuttings respectively. This work is relevant to gardeners, landscaping practitioners and plant scientists in terms of technical-know-how for sustainable production of these ornamental hedges for beautification and research activities.
Keywords: Stem cuttings, Hedges, Basal, Sub-apical, Apical, Rooting

INTRODUCTION

Hedge is a row of closely planted shrubs used to form a boundary barrier or windbreak. In Nigeria, the use of hedges in landscaping date from pre-colonial period when traditional patterns of landscape were established. Today many hedge rows are used in separating residential areas, fields, parks official quarters, institutions, golf courses, wildlife sanctuary and so on. Hedges are valued for their importance in preventing soil loss, reducing atmospheric pollution as a sink for pollutants, reducing flooding, sourcing of fuel wood and provision of shelter for crops, animals and man.

Vegetative propagation involves the production of new plants from shoot, root and leaf organs with meristematic activity that can lead to the initiation of new shoots and roots (Leakey and Simon 2000). It involves the multiplication of offsprings from sources other than seeds. Today, vegetative propagation is one of the most important techniques used for the production of most ornamental plants such as hedges, anywhere in the world. Therefore, any successful establishment of a hedge requires adequate knowledge of it's propagation techniques for uniform, rapid and maximum production of it's seedlings. In stem cutting propagation a portion of the stem is cut from the parent or stock plant to form roots and shoots through manipulation (Hartmann *et al* 2002).

Breynia nivosa, Duranta repens, Gardenia jasminoides, Ixora coccinea and *Mussaendra erythrophylla* area important hedges used all over Nigeria. But inability to produce viable seeds and variation in the nature of their woody stem structure constitute major impediments to use of stem cuttings for large-scale vegetative multiplication of the species. Furthermore, there is inadequate and undocumented information on the propagation techniques of the five species, and available literatures are scanty on effects of stem maturation on the species rooting ability. In addition, the common soil medium available for propagation pose serious limitations for plant propagation due to the presence of soil borne pathogens (Omokhua *et al.,* 2009c); these factors create the need for this study.

MATERIALS AND METHODS

Study Site

The study was carried out in the Department of Forestry and Wildlife Management, Faculty of Agriculture University of Port Harcourt on Lat 04^{0} 35^{1} 38.3^{11} N and long 006^{0} long, 006^{0} 54^{1} 38^{11} E (Omokhua *et al* 2009b)

Experimental Design and Treatment Procedure

A completely randomized design was used with 20 cuttings per subplot and replicated three times per species. The species were *Breynia nivosa, Duranta repens, Gardenia jasminoides, Ixora coccinea* and *Mussaendra erythrophylla:* Apical, subapical and basal cuttings of the 5 species as treatments were set in germination boxes filled with washed and sterilized sharp sand, and placed inside the green house. The cuttings were 10cm long with all the leaves removed from the lower half. The stem cuttings were assessed after 10 weeks of growth for mean percentage rooting of the 5 species. Rooting percentage was calculated by dividing the number of cuttings rooted by number of cuttings set, and multiplied by 100. Analysis of various and descriptive statistics involving means and percentages were used in data analysis.

RESULTS

The results of stem maturation effects on rooting percentage showed significant differences between the apical, subapical and basal cutting of the 5 species at 5% level of probability. *D. repens* had percentage rooting of apical, subapical and basal cutting as 100%, 50% and 9% respectively (Figure 1). *B. nivosa* had percentage rooting for apical, subapical and basal cuttings as 52%, 10% and 0% respectively (Figure 2), *G. jasminoides* had percentage rooting for apical, subapical and basal cuttings as 92%, 94% and 68% respectively (Figure 3). *I. coccinea* had percentage rooting for apical, subapical and basal cutting as 100% 100% and 55% respectively (Figure 4) while *M. erythrophylla* had percentage rooting of 100% for apical, 56% for subapical and 10% for basal cuttings respectively (Figure 5).

DISCUSSION

The finding in this study showed that stem maturation influenced rooting ability of *B. nivosa, D. repens, G. jasminoides, I. coccinea* and *M. erythrophylla.* The stem maturation effects varied from one species to another as well as from one plant part to another. The study revealed that apical cuttings of the 5 species had the best percentage rooting compared to the sub-apical and basal cuttings respectively. The rooting percentage of apical stem cuttings varied from 52% for *B. nivosa* to 100% for *D. repens, I coccinea* and *M. erythrophylla* respectively. The rooting percentage of subapical stem cuttings varied from 10% for *B. nivosa* to 100% for *I. coccinea* respectively. Basal cutting had the lowest in rooting ability with a variation of 0% *B. nivosa* to 68% percentage rooting for *G. jasminoides*.

There have been attempts to correlate stem maturation with rooting ability of cuttings. Hartmann et al. (2002) opined that a continuous stem sclerenchymsing between the phloem and Cortex, exterior to the point of origin of adventitious roots,

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occurs as the stem matures and set older. This sclerenchymsing is few in apical cutting and more in subapical and basal cuttings as the stem matures. This probably is responsible for the more difficult to root nature of the subapical and basal cuttings. This view has also been expressed by Pavise *et al*. (1982) whose work focused on stem maturation on rooting ability of *Ficus pumila*. This does not agree with our observation which revealed that the apical stem cuttings of *Ficus aureus* was difficult to root. This implies that presence of sclerenchyma rings which could block root emergence is not a general rule for all plants species. It may therefore, be concluded that rooting of stem cuttings is related to genetic make-up as well as physiological maturity of plant parts.

Nouim *et al* (2002) reported that vegetative multiplication of organ tree *(Argamaia spinosa)* by cutting is possible but confirm the difficulty of rooting of old lignified cutting. According to him, rooting rate seems to be dependent on genotypes and the best results were from young stems. Mirabla *et al* (2006) reported similar trend on *Eucalytus grandis*. The author observed that juvenility of stem cutting improved rooting ability of *E. Grandis.* Similar observation was reported by Leakey and Courts (1989), the authors reported that juvenile cuttings of *Triplochiton* scleroxylon had better rooting ability than matured cuttings.

CONCLUSION AND RECOMMENDATION

This study has shown that rooting ability of stem cutting in *Breynia nivosa, Duranta repens Gardenia Jasminoides, Ixora coccinea and Mussaendra erythrophylla* is stem maturing dependent. This is evident in all percentages of apical cuttings which was the highest in rooting ability compared to the subapical and basal cuttings.

It can therefore be recommended that apical cutting should be used for any large scale propagration of *B. nivosa, D. repens, G. Jasminoidea I. Coccinca and M. erythrophylla.*

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Comparative Phytochemical Screening of Kenaf and Jute leaves

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Abstract
This study was conducted to evaluate the comparative phytochemical composition of kenaf and jute leaves. The leaves were harvested at maturity, washed, dried, ground to powder and subsequently subjected to quantitativeand qualitative phytochemical screening according to the standard protocols. The results showed that jute leaf contained significantly higher saponin, tannin and glycoside than kenaf leaf. Similarly, jute leaf recorded higher level (25.0%) of flavonoid than kenaf leaf (20.0%). In contrast, kenaf leaf recorded slightly higher level of steroid (0.002%), and alkaloid (0.28%) when compared with jute leaf with 0.001% for steroid and 0.25% for alkaloid. Kenaf leaf contained 56.96mg/100gcarotenoidwhile jute leaf had 54.67mg/100g carotenoid. These leaves appeared to be rich in phytochemicals and anti-oxidants which are good either for human nutrition or medicinal purpose. Screening for the best extraction-solventshowed that water extracted most phytochemicals in both kenaf and jute leaves. Ideally,lipophilic phytochemicals are extracted with protic solvents while hydrophilic phytochemicals efficiently extracted withdistilled water in order to retain their physico-chemical properties.

Keywords*: Kenaf, Phytochemical, Jute, Solvent*.

INTRODUCTION:

Many leafy vegetables are mainly consumed for their nutritional values without much consideration for their medicinal importance. Butonly few species have been explored for its chemical and biological studies.Plants contain chemical substances and most of which are non-nutritive dietary components that are beneficial to human health. These components are called phytochemicals. "Phyto" means that they are plant derivative (Pamplona-Roger,2005). Phytochemicals are chemical compound formed during plant's normal metabolic process. These chemicals are often referred to as secondary metabolite of which are several classes including alkaloids, flavonoids, coumarins, steroids, glycosides, gum, phenol, tannins, terpenes and terpenoids. Phytochemical analyses are of paramount importance for the identification of new sources of therapeutically and industrially valuable compounds with medicinal significance and for the best and most judicious use of naturally available materials (Fallah,2002).

In humans, numerous phytochemicals have been found to be protective and preventive against many degenerative diseases and pathological processes such as: ageing, coronary heart disease, Alzheimer's disease, neurodegenerative disorders, atherosclerosis, cataracts, and inflammation (Birth, 2006). Epidemiological and clinical studies provided evidence that most of these phytochemicals exhibit their protective and disease-preventing functions through their antioxidant activities (Usoh*et al.,*2005; Caragay,1992).In addition, vegetables possess compounds that are essential for their medicinal values, human productive well-being and healthy lifestyle.Most plant leaves are used as medicine while their nutritional potentials are yet to be discovered. The medicinal values of vegetables are due to their phytochemical and other chemical constituents (Forumoto *et al*., 2005).

Recent study showed that jute leaves contain appreciable amount of micronutrients, economic value, proximate compositions and other health benefits while kenaf was reported to possess different medicinal values. For instance, Alexopoulou *et al.* (2013) reported that kenaf leaf was applied to Guinea worms and the stem bark has been used for anaemia in Africa. In addition, Jaihyunk *et al*. (2017) reported the presence of phytocompounds in the hexane extracts of the different parts of the kenaf plant by GC-MS analysis. This publication suggested that phytol andlinolenic acid content of kenaf leaf and stem may be responsible for its medicinal properties. Furthermore, in Ayurvedic medicine, the kenaf leaves are used for bilious, blood, diabetes, coughsand throat disorders (Khare, 2007; Alexopoulou *et al*., 2013; Jin *et al*., 2013). Jute leaves (locally called Ewedu by Yorubas) is commonly used as vegetable in the South western part of Nigeria. Kenaf (*Hibiscus cannabinus* L.) is an annual herbaceous fibre crop and belongs to the same family of *Malvaceae* with jute mallow (*Corchorusolitorius)*, cotton (*Gossypium hirsutum* L), and okra (*Abelmoschus esculentus* L (Webber,1993)).

However, in Nigeria today, kenaf has been accepted as an industrial crop only but it is disheartening to note that kenaf is grossly underutilized in the pharmacological industries as well as in food and nutrition sciences.Presently, there is paucity of information on the phytochemical compositions of kenaf in relation to jute and hence their leaves are under-utilized.It is important to assess the phytochemical compositions of jute and kenaf leaves as a gateway to popularize its medicinal and nutritional uses.

METHODOLOGY

Alkaloid Determination

Five grams of each sample of kenaf leaf and jute leaf were weighed into a 250ml beaker and 200ml of 10% acetic acid in ethanol were added and covered, and allowed to stand for 4hrs. This was filtered and the extract was concentrated on a water bath to one-quarter of the original volume. Concentrated ammonium hydroxide was added dropwise to the extract until the precipitate was completed. The whole solution was allowed to settle and alkaloid precipitated. The precipitate was washed with dilute ammonium hydroxide then filtered and the precipitate was collected after washing with dilute ammonium hydroxide. The residue is the alkaloid which was dried and weighed (Harborne, 1973). Alkaloid was determined using the equation.

$$\% \text{ Alkaloid} = \frac{\text{Final weight of the dried content}}{\text{Weight of the sample}} \times 100 \quad (1)$$

Saponin Determination

The kenaf and jute leaf samples were pound differently and 20g of each were put into a conical flask and 100cm^3 of 20% aqueous ethanol were added. The samples were heated over a hot water bath for 4hrs with continuous stirring at about 55^{o}C. The mixture was filtered and the residue re-extracted with another 200ml 20% ethanol. The combined extracts were reduced to 40ml over water bath at about 90^{o}C. The concentrate was transferred into a 250ml separation funnel and 29ml of diethyl ether was added and shaken vigorously (Harborne,1973).

Tannin Determination

500g of each leaf sample were weighed into a 50ml plastic bottle. 50ml of distilled water were added and shaken for 1hr in a mechanical shaker. This was filtered into a 50ml volumetric flask and made up to the mark. Then 5ml of the filtrate werepipetted out into a test tube and mixed with 2ml of 0.1m feed in 0.1N HCl solution and 0.008m potassium ferro-cyanide. The absorbance was measured at 120nm.

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Glycosides Determination

5g of each sample was weighed into a beaker and 100ml of distilled water were added. The sample were soaked for 3hrs and filtered to get filtrate. 1ml of filtrate were pipetted into a test tube,2ml of 3,5-DNS (dinitrosalic acid) were added and boiled in a water bath for 10-15minutes, the mixture was allowed to cool in the test tube and 10ml distilled water were added and the absorbance at 540mm for glycoside were read up. Percentage glycoside wasbe determined using the formula:

$$\% \text{ Glycoside} = \frac{\text{Mean absorbance } x \text{ Vol of extract } x \text{ 100}}{1000 \text{ } x \text{ weight of leaf sample}} \quad (2)$$

Flavonoid Determination:

The percentage flavonoid content of kenaf and jute leaves was determined by Boham and Kocipai-Abyazan (1974) in which 5.0g of each sample wasextracted three times with 100ml of 80% aqueous methanol at room temperature. The whole solution (125ml) was filtered through Whatman filter paper. The filtrate was later transferred into an evaporating dish and evaporated into dryness and weighed to a constant weight.

$$\% \text{ Flavonoid} = \frac{\text{Final weight of the dried content}}{\text{Weight of the sample}} \text{ x 100} \quad (3)$$

Statistical analysis

Data obtained were analysed in triplicates by one way analysis of variance (ANOVA).Means were compared using T-test at $p < 0.05$

Qualitative Analysis

Ten grams (10g) of kenaf and jute leaves were weighed into four different labelled conical flasks.100ml of four different solvents (distilled water, methanol,ethanol and ethyl acetate) were poured into the four different conical flasks to extract the phytochemicals. After 24hrs, the mixtures were filtered using whatman filter paper (No.1) into conical flasks. The filtrates were concentrated by placing the flasks into water bath at 100°C.The resulting filtrate were cooled to room temperature. Qualitative tests were then conducted on the cool solution as prescribed by Azubuogu (2012).

Preparation of Wagner Reagent

13g of iodine crystal and 2.0g of potassium iodide were dissolved in water in a 100ml volumetric flask and the solution was made up to 100ml

Preparation of Mayer's Reagent

1.3g of mercuric chloride and 5.0g of potassium iodide were dissolved in distilled water in a 100ml volumetric flask and the solution was made up to 100ml.

Test for Alkaloids: (a) 1ml of 1% HCl was added to 3ml of each of the extracts in a test tube. The mixture was heated for 20mins in a water bath. While heating, it was shaken continuously. The mixture was cooled and filtered. The procedure was repeated with each extract. (b) 1ml of each filtrate from (a) above was added to 0.5ml of Mayer's reagent.

Observation: A creamy colour change.

(c) When 1ml of each filtrate from (a) above was added to 0.5ml of Wagner's reagent.

Observation: A brown colour precipitate.

Test for Saponin:

(a) Frothing test: 3ml of each extract was measured into a test tube and 2ml of distilled water was added and then the mixture was shaken vigorously.

Observation: A persistent frothing was observed. The frothing was persistence in the extract. Note: Frothis a mass of small bubbles especially on the surface of a liquid.

(b) Emulsion Test: 3ml of each extract was added to 5 drop of olive oil in a test tube and the content was vigorously shaken.

Observation: Emulsification was observed which indicates the presence of saponin.

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Test for Flavonoids: 3ml of each extract was added to 10ml of distilled water in a test tube and the solution was shaken. 1ml of 10% NaOH solution was added to the mixture.

Observation: Yellow coloration was observed. Absence of yellow coloration in the mixture indicates that flavonoid was not present.

Test for Steroids: Salkowski Test: 5 drops of concentrated H_2SO_4 were added to 1ml of each extract in a separate test tube.

Observation: A red coloration was observed indicating the presence of steroid.

Test for Tannin: 2ml of each extract in a separate test tube were boiled gently for 2minutes and allowed to cool. 3 drop of ferric chloride solution were added to each extract

Observation: Orange coloration was observed.

Glycosides: 1ml of aqueous extract was mixed with 1ml of 20% solution of 3,5-dinitrosalic acid in methanol and 1ml of a 5% aqueous NaOH was added.

Observation: An immediate bright orange colour was observed indication of the presence of cardenolides in the extract. The colour faded gradually through reddish brown to brownish yellow. This indicatedthe presence of glycosides. Boiling in water gives it a brick red coloration.

RESULTS AND DISCUSSION

The role of extraction-solvent is important in phyto-screening. Naturally, water-soluble phytochemicals like flavonoids are best extracted with wateras to retain the physicochemical properties of phytochemicals while lipophilic phytochemicals are effectively extracted with protic solvents such as ethyl acetate among others. The results in table 1a showed that the effect of the four solvents on the extraction of phytochemical from kenaf and jute leaves. Ethanol and methanol extracted saponin, andtannin, ethyl-acetate extracted alkaloid, saponin, glycoside and tannin, and water extracted saponin, flavonoid steroids and glycosides. In all the solvents used, only water extracted most of the phytochemicals in jute leaves, the reason may be that water is a universal polar solvent. On the other hand, the results in Table 1b showed the effect of the four solvent on the extraction of phytochemical kenafleaf. Ethanol and methanol extracted saponin and tannin. Ethyl-acetate extracted alkaloid, glycoside, saponin and tannin and lastly water extracted flavonoid, alkaloid, saponin and glycoside. From the result table water and ethyl-acetate extracted most of the phytochemicals in the kenaf leaf sample.

The results in table 2 showed that the alkaloid content in kenaf leaf was significantly higher than that of jute leaf. This result is supported by the findings of Okoye and Ebeledike (2013) that the presence of alkaloids signified the possession of medicinal properties within the leaves. Thesaponin content of jute leaf was slightly higher than that of kenaf leaf, however, the two leaves possessed lower level of saponin compared to *moringa oleifera* and *Azadirichta indica* leaves (Azubuogu, 2012).Similar trend of values was observed for the tannin in which jute leaf had 0.01% while kenaf leaf had 0.003%. This result was significantly lower than 0.08% tannin reported for *Moringa oleifera* and *Azadirichta indica* leaves by Azubuogu (2012).These results are in strong agreement with the findings reported on the phytochemical constituents of *Piper guineense* (Uziza*)* by Okoye and Ebeledike (2013).The outcomes of this research work uphold the assertion from the literature studies that kenaf leaves should be used as vegetable food since it contains valuable vitamins and minerals. Similarly, jute leaf contained slightly higher flavonoid

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and glycoside compared to kenaf leaf. Conversely, the level of glycoside obtained in kenaf and jute leaves were significantly higher than the 0.005% glycoside recorded for Moringa oleifera leaves by Azubuogu(2012). The observation of this study are in agreement withmany literatures that the extracts exhibited antibacterial activity due to the presence of tannins, saponinand alkaloids (Jaihyunk *et al*., 2017; Yao *etal*., 2005). Jute leaf appeared to be a rich source of flavonoids which inhibit free radical chains reactions and flavonoids possess antioxidant activity, and equally anti-inflammatory and antiviral have the ability to lower cholesterol level (Okoye and Ebeledike, 2013). On the other hand, kenaf leaf recorded higher level of carotenoid and steroid than jute leaf. However, both jute and kenaf leaves proved to be the potential sources of carotenoids which are precursor for retinol synthesis (vitamin A). Carotenoid is also antioxidant and it plays essential role in scavenging free radicals which cause degenerative diseases (Caragay, 1992). The phenolic and flavonoid compounds present in the plant tissue suggest its medicinal importance (Kobaisy *et al*., 2001; Nyam *et al*., 2009; Jin *et al*., 2013; Ghafar *et al*., 2013). The results of this study strongly supportthe findings of Jaihyunk *et al*.(2017) that the functional groups in phenolic and flavonoid compounds present in the kenaf plant exhibit antioxidant properties and inhibitthe angiotensin I-converting enzyme and lipid peroxidation.

From the results of this study,it can be concluded that kenaf and jute leavescontain phytochemicals (flavonoid, alkaloids, tannin, glycosides, carotenoid, saponin, and steroids). These leaves are rich in phytochemicals and antioxidants, may be explored for their nutritional and health benefits.

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Table 1a: Qualitative phytochemical screening of jute leaf extract from different solvents

Parameter/ Solvent	Distilled Water	Ethanol	Ethyl-acetate	Methanol
Alkaloids	—	—	+	—
Flavonoids	+++	—	—	—
Glycoside	++	—	+	—
Saponin	+	+	++	+
Steroids	+	—	—	—
Tannin	—	+	++	+

Key**:** + Means present, ++ mildly present, +++ densely present, — absent

Table 1b: Qualitative phytochemical screening of kenaf leaf extract from different solvents

Parameter/Solvent	Distilled water	Ethanol	Ethyl-acetate	Methanol
Alkaloids	+	—	+	—
Flavonoids	+++	—	—	—
Glycoside	+++	—	+	—
Saponin	+	+	+++	+
Steroids	—	—	—	—
Tannin	—	+	++	+

Key: + Means present, ++ mildly present, +++ densely present, — absent

Table 2: Comparative phytochemical content of kenaf and jute leaves

Phytochemical	Kenaf leaf	Jute leaf
% Alkaloid	0.28a	0.25 b
%Saponin	0.15b	0.16 a
%Tannin	0.003 b	0.01a
%Glycoside	0.10b	0.11a
%Steroid	0.002a	0.001b
% Flavonoid	20.00b	25.00a
Carotenoid(mg/100g)	56.96a	54.67b

Values are means ± SD of triplicate determination. Values with the same letter in a row are not significantly different (P<0.05)

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Studies on Light Intensity Requirements of *Begonia scapigera* Hook. f. for Possible Domestication

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Abstract
Begonia scapigera Hook .f. is a yellow flowered rhizomatous begonia of promising ornamental values. It is one of the species facing extinction due to habitat destruction. The grove at Erin-Ijesa, Odo-Oba (Iwo) in Osun State and Obudu ranch in Cross Rivers State where begonia was reported to exist were surveyed to determine the effects of light intensity on the survival of this plant.The Erin-Ijesa site was divided into three cardinal points based on the population of begonia found growing there. The light intensity of each segment was monitored during the onset and peak of rains in 2006 and 2007 at 900h 1200h and 1500h. Light intensity at the westward and opposite the fall was similar at 0900h, 1200h and 1500h in 2006 and 2007. April and May of both years at the cardinal points received higher light intensity when compared with July and August. The eastward received the highest light intensity with the least population of begonia in April/May and at the peak of rains (July/August) in 2006 and 2007.It was followed by thewestwardand area opposite the fall bothat the onset and the peak of rains in 2006 and 2007. Areas with light intensity range of 2,211-2,727 Lux accommodated higher population of Begonia. Few populations were found on a single rock surface at Obudu because of its low light intensity while no begonia was found at Odo-Oba with direct light intensity of 2,066-2,964 Lux and above. The area was usually submerged during the rainy season. B.scapigera could only survive under a bright but indirect light.
Keywords: *Begonia scapigera,*light intensity, habitat destruction, rhizomatous begonia, ornamental.

INTRODUCTION

Light intensity or light quality refers to the total amount of light that plant receives. It is also the degree of brightness that a plant is exposed to. Different plants have optimum requirement and both deficient and excessive light intensities are injurious (Bareja, 2011).The intensity of light changes with the time of the day,season of the year,geographic location,distance from equator and weather. It gradually increases from sunrise to the middle of the day and then gradually decreases towards the sunset. Maximum intensity occurs at the equator and gradually decreases with increasing distance from the equator to the south and north poles. It is also affected by dust particles and atmospheric water vapour, slope of land and elevation. The most important process triggered by light in plants is photosynthesis. Photosynthesis is a process used by the plant to produce food to help build more plant material. The faster the photosynthetic rate, the faster the plant grows. The rate of photosynthesis is impacted mostly by the light intensity and quality. When it comes to flowering, the length of the day is important to know as it directly impacts the timing of flowering for many ornamental crops. For example it is impossible to cause a short-day plant like poinsettia to bloom in the summer under natural conditions.(Edmund *et al*, 1978, Lopez, 2018).

Light is one of the most important factors in the life of plants. Its main properties are quality, intensity and duration (Jolankai and Birkas, 2007). Plants grown under high light intensity will have smaller and thicker leaves, a smaller shoot/root ratio and be more branched than plants grown with lower conditions. Density, height and structure of the crop influence the distribution of light within the crop and thus the form of the plant. Maximum efficiency of light in photosynthesis could be obtained only under relative low light. When intensities are high, light passes through the leaves and it is reflected from them. At low intensities, a high proportion of light may be absorbed and used (Janick, 1998). Janick (1998) further observed that short crops with leaves close to the ground seem to be more efficient producers than forest in which leaves are spread over a wide range of height. This is probably because in short crops a smaller percentage of leaves are exposed to light below the compensation point. This may be the reason why begonia could survive under low light intensity in the thick rain forest.

Although many begonias naturally grow on the forest floor, in cultivation outside their natural environment they require moderate light intensity. Studies have shown light to be of great importance for their growth and development, and hence, their commercial production (Nowak and Field, 1993; Myster, 1999). Many begonias are classified as shade-demanding understory species, and have leaves that are highly adapted to deep shade (Lee *et al*., 1990). As a result, they are often propagated under low light levels (Myster, 1999) and can suffer damages if transferred to full sunlight. In warm sunny areas, begonias should not receive bright direct sunlight. Light should be indirect (scattered off surrounding objects) or filtered (e.g. by netting or trees) (The Begonian, 1980; Tebbitt, 2005). According to Thompson (2003), different begonia species require different amount of light for optimum growth. Plants grown in too dark a location will have unnaturally pale foliage that is stretched towards bright light source. Plants receiving too much light will have pale, bleached leaves with dry brown margins. Working on *Begonia x erythrophylla* J. Neuman (a hybrid begonia) mostly grown as indoor pot plant with large well-formed leaves to maximize light interception, Burritt and Mackenzie (2003), observed that its fully expanded leaves exhibited rapid photo-bleaching when exposed to full sunlight. This was as a result of strong inhibition of photosynthetic efficiency which was followed by a slow and incomplete recovery.

Very bright condition will cause some species to develop some amount of red or purple pigments in their stems and leaves rather than being bleached. This disappears once the plant is moved to a right place with appropriate light intensity (Thompson, 2003; Tebbitt, 2005). Increasing light quality and temperature will promote the production of anthocyanin which produced variegation in leaves (Hoskins, 2003). Light quality can influence size and colour of flowers, quantity of inflorescences and flower abortion, more light means larger and sometimes more flowers in different flowering pot plants and a longer keeping quality (Fjeld, 1986).

Early morning or late afternoon sunshine has been found excellent to the growth of begonias (Begonia Care, 2007; Stewart, 2009). Indoor begonias grow best in bright but indirect sunlight. Rhizomatous begonias grow nicely when given adequate light without strong direct sunlight. Too much light will give yellow foliage and poor plant development (The Begonian, 1980). In general begonias need light to flower well. Some will burn if light is too intense (Son and Yeam, 1987). Light has been equally found as a factor necessary for the germination of begonia seeds. Foliage of some begonia reacts to different light intensities, for example *Begonia solimautata* L B Sm & Wassh from Brazil had its leaves changed to brownish from dark green when grown under direct sunlight (Thompson, 2003).

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Low irradiance resulted in poor begonia plant quality by producing weak stems, reduced growth and number of flowers. Also shoot dry weight, lateral shoot leaf area, total leaf area and node number of *Begonia x Semperflorens-cultorum* Hort. decreased with increasing shade over time (Kessler and Armitage, 1992). *B. albopicta* W. Bull plants grown under full sunlight grew stunted and compact than those grown under shade. Full sun and 41% shade resulted in reddish, cup-like leaves of *B. echinosepala var. elongatifolia* Regel plants (Jeong *et al*., 2009). The aim of this work therefore was to identify the light intensity requirements that promote the growth of *B. scapigera* in its natural habitat, which could be used in its domestication.

MATERIALS AND METHODS

Selected sites in Nigeria where *Begonia scapigera* was reported to be foundwere visited. These were Erin-Ijesa waterfall and Odo-Oba near Iwo (both in Osun state) as well as Obudu Cattle Ranch in Cross River state (Hutchinson and Dalziel, 1958; Jayeola, 2003, personal communication).A field survey to determine its occurrence, abundance, in relation to environmental factor such as the light intensity of the sites was carried out. Erin-Ijesa waterfallpopularly known as Olumirin waterfallis located on the outskirt of Erin-Oke in Oriade Local Government Area of Osun State,Nigeria which lies within latitude 7º30ʾand 8º 45ʿ N, and longitude 4º 31ʿand 5º E. Erin-Oke is about 55 km from Akure, Ondo state along Akure-Ilesa road, while it is about 16 km from Ilesa in Osun state. Erin-Ijesa waterfall is located at an altitude of 423 m above sea level.

The Odo-Oba site is located on the outskirt of Iwo town along Iwo –Ibadan roadbetween latitude 07º 37’ 7” and 07º 37’ 9” N and between longitude 04º 08’ 35” and04º 08’ 45”E. It is very close to the boundary of Osun and Oyo states. The area is characterized by scattered big trees, brokencanopy and partial shade over the river hence less-dense vegetation. The grove, which is located on the river bank, has a depression of about 3 m. UnlikeErin-Ijesa and Obudu, there is no waterfall in the Odo-Oba location. Obudu Cattle Ranch, now known as Obudu Mountain Resort, is a resort and ranch located at Obanliku local Government Area on the highlands of Cross River state in the south eastern part of Nigeria. It is located within latitude 5º 57ʾ54”and 5º 58ʾ 8”N, and longitude 8º42ʿ 20” and 8º42ʿ40” E.The resort has a low temperature due to its high attitude of 1, 576 m above sea level hence exhibiting a semi- temperate climate.

The Erin-Ijesa site was divided into three cardinal points as follows: the westward (the left side of the waterfalls), the eastward (the right side of the waterfalls) and the area opposite the fall from the entrance of the grove. Areas measuring 50x50 cm were randomly sampled for counting. This was marked out on the rock surface in the area where begonia was found growing.The light intensity of the grove where the plant was found was observed at 0900 h, 1200 h and 1500 h for three randomly selected days in four months per year, for two years (2006 and 2007) using the Extech’s Lux meter model 40102.The photometer was held directly near the plantsurface to trap the bright beam falling on the leaf surface. Light was allowed to pass through it and the value recorded on the digital screen. The light intensity of each area of the sites was obtained from the digital readings of the meter in lux from where the mean intensities were obtained. Readings were taken from only one point each at Iwo and Obudu.

RESULTS AND DISCUSSIONS

Erin-Ijesa is made up of layers of mountains with rock outcrops. Between the rocks are tall trees, which form dense vegetation and close canopy that gives

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shade to the area, resulting in reduced light reception with some part receiving bright, but indirect sunshine. The trees are in strata, as characteristic of the tropical lowland rainforest.The forest is being affected by human activities especially log felling resulting in uneven light distribution in the grove.Begonia was found growing on the rock surfaces near the pool of water.

In 2006, the grove received mean light intensity of 2,714 Lux in the morning (0900 h), 2,871 Lux at noon (1200 h) and2,110 at 1500 h (Table 1). Daily mean light intensity of 3,093Lux, 2,391 Lux and 2,211 Lux was observed at the eastward, westward and the area opposite the fall respectively. During the rainy season (July/August), the grove experienced less light intensity at different periods of the day and at the different areas under observation. The eastward received the highest light intensity of 2,214 Lux followed by the westward area with 2,161 Lux while the least daily mean intensity of 1,618 Lux was obtained at the area opposite the fall.The observed light intensity in2007was similar to that obtained in 2006 (Table 2). Light intensity at noonday was higher during the dry season than the rainy season with the eastward part having the highest mean daily intensity. The area opposite the fall hadhigher light intensity than westward in April/May but reverse was experienced in July/August. The light intensity was higher during the dry season (April/May) in 2006 than 2007 (Table 1& 2). The mean daily light intensity at Odo-oba was higher than that of Erin and Obudu while the lowest daily intensity was observed at Obudu during the dry and rainy seasons(table 3).

The eastern part of the grove had the highest sunlight intensity owing to its reduced vegetation. Few begonia plants were found in this area and most were pale green in colour. This is in agreement with the findings of The Begonian (1980), Son and Yeam (1987) and Kessler and Armitage (1992) that begonias can burn or become pale if the light intensity is too high. Working on *Begonia x erythrophylla* mostly grown as indoor pot plant with large well-formed leaves to maximize light interception, Burritt and Mackenzie (2003), observed that its fully expanded leaves exhibited rapid photo-bleaching when exposed to full sunlight. Very bright condition will cause some species to develop some amount of red or purple pigments (anthocyanin) in their stems and leaves rather than being bleached (Thompson, 2003; Tebbitt, 2005).The abundant indirect sunlight at the western side of the grove was associated with thegood population of begonia. *B.scapigera* in this area were luxuriant, well-branched, and large-leaved with flowers. The leaf colour was darker compared with those from the eastern part.The intensity of sunlight decreased in the grove at the peak of the rains(July/August) due to cloud formation and thick vegetation. The grove however received higher light intensity at the onset of the rains when there was less cloud cover, reduced vegetation due to leaf fall and increase in splashed water droplets. This is in agreement with the findings of Edmund *et al*., (1978) and Lopez, (2018). High light intensity observed at the eastward part of the grove was associated with low population and poor quality of begonia. This agrees with the work of Kessler and Armitage (1992). Jeong *et al.* (2009) working on six begonia species, also observed that growing begonia under full sunlight and 41% shade resulted in stunted and compact plants, with red cup-like leaves in *Begonia echinosepala* var. *elongatifolia*.The grove at the Obudu Cattle Ranch had lower light intensity when compared with Erin-Ijesa, hence fewer population of begonia. Odo-oba could no longer support the growth of

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Begonia as a result of the excessive light intensity.

CONCLUSION

It could be concluded that *Begonia scapigera* requires high, bright but indirect, fairly stable light intensity for its maximum growth. Survival under low and high but direct light intensity was poor.

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Table 1 MeanLight Intensity (Lux) of the grove where *Begonia scapigera* was found at Erin-Ijesa at different times of the day during the dry seasons 2006 and 2007.

	Time of the day							
Area of the Grove	0900 h		1200 h		1500 h		Mean	
	2006	2007	2006	2007	2006	2007	2006	2007
Eastward	2800	2739	3270	2798	3210	2765	3093	2767
Westward	2600	2708	2491	2743	2081	2729	2391	2727
Opposite the Fall	2742	2714	2852	2770	1040	2750	2211	2745
Mean	2714	2730	2871	2770	2110	2748		

Table 2. Mean light intensity (Lux) of the grove where *Begonia scapigera* was found at Erin-Ijesa at different times of the day during the rainy season (July and August) in 2006 and 2007.

	Time of the day							
Area of the Grove	0900 h		1200 h		1500 h		Mean	
	2006	2007	2006	2007	2006	2007	2006	2007
Eastward	2206	2290	2227	2300	2210	2248	2214	2247
Westward	2106	2280	2196	2280	2182	2162	2161	2201
Opposite the Fall	1609	2165	1650	2220	1595	2140	1618	1580
Mean	1974	2245	2024	2267	1996	2183		

Table 3: Mean light intensity (Lux) of Obudu Cattle Ranch and Odo-Oba (Iwo) in 2007.

	Obudu Cattle Ranch		Odo-Oba (Iwo)	
	Season		Season	
Period of the day	Dry	Rainy	Dry	Rainy
0900 h	1,156	906	2,432	2,065
1200 h	1,290	1,147	2,964	2,579
1500 h	1,185	1,056	2,722	2,321
Mean	1,210	1,036	2,706	2,322

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Vegetative Propagation of Duranta (*Duranta erecta*) Using an Organic Growth Stimulator.

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Abstract
Vegetative propagation using cuttings is seen as a more practical technique for multiplication of many ornamental plants in spite of the introduction of advanced technologies such as the in-vitro propagation techniques which include tissue culture techniques. An experiment on the stimulation of rooting of Durantha erecta using coconut water was carried out at the ornamental plants nursery of the Floriculture Programme, National Horticultural Research Institute, Ibadan in June, 2017. The experiment was a two factors experiment with concentration of coconut water and dipping duration; the concentrations were 0:100, 25:75, 50:50, 75:25 and 100:0 coconut water: water respectively on v/v basis, while the cuttings were for 0, 15, 30, 45 and 60 minutes duration respectively. Treatments were laid out in completely randomized design (CRD) with 3 replicates, made up of 5 Durantha erecta cuttings (20cm long) per treatment to give a total of 225 experimental units. Results showed that Durantha erecta cuttings dipped for 30 minutes produced significantly higher for leaf number at 4WAP (1.95), while soaking for 30 and 45 minutes produced the highest number of branches (0.96) at 4 WAP. Dipping in coconut water produced non-significant responses as compared to the control: number of leaves and branches were produced by the control (2.19 and 2.08 respectively). Significant interactions were observed between the soaking duration and concentration of coconut water used.
Keywords: Duranta, Propagation, Coconut water, Growth stimulator

INTRODUCTION

The role of ornamental plants in the beautification and management of the environment cannot be over emphasized;, they make public and private spaces conducive for relaxation and enjoyment (Day and Loveys, 1998). Ornamental plants are usually grown for their aesthetic features which may include, foliage, and fragrance among other features .

The propagation of most ornamental plants is usually through vegetative means usually by cuttings, layering or grafting of vegetative organs which include stems, leaves, roots or terminal buds (Deng Xiong, 2000).,

Duranta erecta L. var. Variegata also known as Yellow Duranta, is a sprawling shrub or a small tree belongs to Family Verbenaceae. Native to West Indies. It can grow to 6 m tall and can spread to an equal width. It is planted as much for its yellow and green variegated foliage and for its lavander flowers that appear almost all year round (Huxley *et al*., 1992). It is widely grown as an ornamental plant throughout tropical and warm subtropical regions for its creamy yellow margins around the 1-2 inch long serrated leaves, as well as for its showy flowers and fruits that make it a desirable addition to garden. It can be used as a hedge and bringing the potted garden an unique burst of colour and form. Used as basket plant, a mounding bush or train into a standard (Rowezak, 2001). The common method of propagation is by using seeds or cuttings which necessitates the need to develop methods to induce rapid emergence of adventitious roots.

Inspite of the tremendous potentials of ornamental plants, moderate and difficult-to-root plant species can prevent producers from realizing their full potential as propagators (Okunlola, 2013). Application of growth stimulator and rooting hormones are the keys to overcoming this challenge, which ultimately leads to an increase in product diversity (Kesari et al. 2010). Many ornamental plants have been said to reproduce under natural conditions by asexual means (Mohammed and Hamid, 2014)

The success of rooting ornamental plant cuttings depend on their growth responses, based on nutrient present with the aid of growth promoting substances before planting (Longman, 2002).

Adventitious root formation is a key step in vegetative propagation of woody or horticultural species, and problems associated with rooting of cuttings frequently result in significant economic losses (De Klerk *et al.,* 1999 and Rowezak, 2001).

The use of coconut water as a growth-promoting component can be traced to more than half a

century, when Overbeek *et al.* introduced it as a new component of the nutrient medium for

callus cultures in 1941.

Coconut water contains plant growth hormones such as auxin, gibberellins, cytokinis and natural inhibitors and regulators which include ethylene, abscisic acid, phenols and flavonols (Juanita *et al.*, 1988). Cytokinins such as zeatin and kinetin have been present in coconut water (Mauney et al., 1952). Therefore, it can be used to improve the rooting of cuttings and it is a cheap source of nutrients, freely accessible and environmentally friendly.

The objective of the study was to determine the effects of dipping duration and concentration of coconut water on rooting and growth of *Durantha erecta*

There is a need to carry out extensive studies on the enhancement of the rooting of cuttings of Duranta using coconut water. Hence, an attempt was made to test the effect of coconut water on the rooting of cuttings of Duranta.

MATERIALS AND METHODS

The experiment was carried out at the Floriculture garden of National Horticultural Research Institute (NIHORT), Ibadan, Nigeria (7025"N and 3025"E) in 2017. The experiment was made up of two factors which were concentration of coconut water and dipping duration; the concentrations were 0:100 v/v coconut water: water, 25:75 coconut water: water, 50:50 v/v coconut water: water, 75:25 v/v coconut water: water and 100:0 v/v coconut water: water for the dipping duration; 0 minutes, 15minutes, 30 minutes, 45 minutes and 60minutes. Treatments were laid out in completely randomized design (CRD) with 3 replicates, made up of 5 *Durantha erecta* cuttings (20cm long) per treatment giving a total of 225 experimental units.

Data Collection and Analysis

Data collected includes number of leaves, number of branches, percentage rooted cuttings, plant height and all parameters were subjected to Analysis of Variance (ANOVA) to determine the level of significance of the effect of the treatments on the cuttings

RESULTS AND DISCUSSION

The results shows the effects of coconut water and dipping duration on leaf and branch production ability of *Duranta erecta* with cuttings dipped for 30 minutes having the best performance for leaf production at 2WAP and 4 WAP, while for the effect of coconut water concentration 25% CW on leaf production, the highest number of leaves.

For number of branches. At 3WAP the Duranta cuttings dipped for 15 minutes produced the highest number of branches, while in the 3 WAP and 4 WAP performed better than other soaking durations in the course of the study which agrees with Amrut and Rajput (2013) which reported that application of coconut water increased the number of branches in fenugreek plant compared thereby suggesting that the growth hormones present in the coconut water responsible for cell elongation and cell division and resulted in increased number of branches.

The cuttings formed callus but there were no roots which could be as a result of a couple of factors; Rooting is encouraged by moisture, warmth (air temperature

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should be below that of the soil), and good aeration.

The callus tissue and the roots arise from the cambium and the formation of callus is a necessary preliminary to rooting, although roots do not arise in the callus, but from the cambium immediately behind it.

CONCLUSION

This study has shown that coconut water can enhance the vegetative growth of Duranta but there is a need to carry out more studies on other factors that play important roles in the rooting of Duranta.

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Table 1: Effect of dipping duration and concentration of coconut water on rooting and growth of *Duranta erecta*

	Number of leaves				Number of branches			
	Weeks after planting							
	2	4	5	6	3	4	5	6
Dipping Time								
0	0.78^{e}	1.13^{d}	2.07^{b}	3.29^{a}	0.36^{d}	0.51^{d}	1.54^{a}	1.75^{c}
15	0.93^{d}	1.42^{b}	1.71^{d}	2.60^{e}	0.80^{a}	0.60^{c}	1.20^{d}	1.47^{d}
30	1.89^{a}	1.95^{a}	1.56^{e}	2.76^{d}	0.65^{b}	0.96^{a}	1.36^{c}	1.51^{e}
45	1.53^{b}	1.37^{c}	2.25^{a}	2.93^{b}	0.40^{c}	0.96^{a}	1.36^{c}	1.80^{a}
60	1.13^{c}	1.13^{c}	1.98^{c}	2.91^{c}	0.29^{e}	0.65^{b}	1.49^{b}	1.76^{b}
Concentration of coconut water cw/water								
0/100	1.64^{b}	2.06^{a}	3.80^{a}	2.19^{a}	0.69^{b}	0.84^{b}	1.64^{a}	2.08^{a}
25/75	2.24^{a}	1.80^{b}	3.13^{b}	1.84^{c}	0.76^{a}	0.73^{d}	1.42^{b}	1.67^{b}
50/50	0.80^{d}	1.18^{d}	2.78^{c}	2.07^{b}	0.38^{c}	0.75^{c}	1.40^{c}	1.66^{c}
75/25	0.87^{c}	0.73^{e}	2.58^{d}	1.78^{d}	0.31^{e}	0.31^{e}	1.22^{d}	1.33^{d}
100/0	0.73^{e}	1.24^{c}	2.20^{e}	1.67^{e}	0.36^{d}	1.05^{a}	1.16^{e}	1.33^{d}

Means followed by the same alphabet subscript in the same column are not significantly different at ($P< 0.05$)

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A Survey on Ginger Production and Related Issues in Buruku Local Government Area of Benue State, Nigeria

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Abstract
A study was conducted in Burruku Local Government Area of Benue state in April, 2018using structured questionnaire and focused group discussion. Districts selected for the study were Mbaazagee, Mbakula, Mbatyough, Mbaade and Shorov. In each district, 10 questionnaires were administered to ginger farmers.Results showed that the bulk of the producers are from the age of 60 and above. The enterprise is also dominated by people with primary and secondary education, although some percentage (0 – 20%) do not have any form of formal education. All the respondents were married with household size of 6 – 9predominating.Most of the respondents had 6 – 10 years experience in ginger production. Majority had farm size ≤ 1.5 ha. In terms of cropping system, 80 – 100% of respondents cultivate ginger as sole crop in open fields while a small percentage (20%) in Mbaazagee cultivate ginger under tree shade. The variety planted by all the farmers was the black ginger.Seed rhizomes weight is in the range of 20 – 30g with 2-3 eye buds.Only inorganic\fertilizers are applied which is either Urea and/ or NPK.Mother rhizome removal is practiced by all the respondents at some point after planting, for commercial purposes.Harvested rhizomes are stored in bags or pits under cool weather condition.Most of the respondents obtained rhizome yield of 100 – 5000kg and realized gross income of between #100,000 and #300,000 in 2017. Challenges encountered in the enterprise revolve around finance, input and marketing.
Key words: Ginger production, Survey, Benue State

INTRODUCTION

Ginger, (*Zingiber officinale*) is a perennial rhizomatous herb usually cultivated as an annual, and which is much appreciated throughout the world (Kaushal *et al*., 2017). Although the exact centre of origin is not known with certainty, it is believed to have originated from south East Asia and has been grown in India and China for centuries (Valenzuela, 2008). Presently ginger is cultivated throughout the humid tropical areas of the world (Meadows, 1998).

Ginger is considered the most widely used spice globally (Kaushal *et al.,* 2017). Its value as a spice stems mainly from its aroma and pungency (Paull*et al* 1988). It is also valued as a medicinal plant widely used throughout the world to address a wide range of human ailments such as arthritis, cramps, rheumatism, constipation, fever and infectious diseases (Ali *et al.,* 2008).Apart from the use of the rhizomes as fresh paste, dried powder/slices and ginger tea (El-Ghorab *et al.,* 2010), it can be used in the production of many commercial products such as cookies, candy, jam, alcohol, bread, ginger ale, curry powders, soft drinks and a lot of other products (Kaushal *et al* 2008; Maxwell, 2008).

Globally, ginger production was estimated at over 1.4 million metric tons in 2008 with India, China, Indonesia, Nepal and Nigeria as the major producing countries (FAO, 2008). In Africa Nigeria is the leading producer of this important horticultural commodity. Major importing countries are United Kingdom, United States, Japan and Saudi Arabia, with US and Japan recognized as the leading importers (Zamil, 2015); Although Nigeria ranks first globally in terms of land area devoted to ginger cultivation (56.23% of the total), it ranks third in terms of quantity of ginger produced, accounting for 12.54%

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of global production (Zanil, 2015). This scenario depicts low productivity of the crop in Nigeria. To improve productivity, an understanding of prevailing production practices and associated issues is pertinent. It was therefore decided to make a survey of ginger production practices, yield, storage and marketing among farmers in Buruku Local Government Area of Benue state, an area that is renowned for production of the commodity.

METHODOLOGY

The study was conducted in Burruku Local Government Area of Benue state in April, 2018. The Local Government iscomprised of 12 districts otherwise called council wards (Wikipedia, 2018). Five out of the 12 districts were purposefully selected for the study because of their high level of involvement in ginger production.

The study used structured questionnaire and focused group discussion (25 persons) involving ginger farmers. Districts selected for the study were Mbaazagee, Mbakula, Mbatyough, Mbaade and Shorov. In each district, questionnaires were administered to 10 ginger farmers. As such, a total of 50 farmers were interviewed in the Local Government. Information obtained covered demography, production practices, yield, storage, marketing and challenges. Data collected were analyzed using percentages and presented in tables.

RESULTS AND DISCUSSION

Demographic features of Ginger producers

Table 1 is a summary of the demographic characteristics of ginger producers in the surveyed locations. The bulk of the producers are from the age bracket of 60 – 79 and 80 and above. In Mbaazagee and Mbatyough, men predominate in the cultivation of ginger while in Mbakula, the opposite is the case. In the remaining districts the proportion is the same between male and female. The absence or near absence of younger people in the production of ginger is a disturbing trendand might be due to ignorance of the high economic gains achievable from this activity or may be a dislike for the tasking farm operations that characterize ginger production. This latter point was confirmed in the course of interaction with the producers.

All the respondents were married. From thediscussion with them, they explained that family labour is employed for ginger production without any recourse to hired labour whatsoever. This may explain why only married people venture into this enterprise. The enterprise is also dominated by people with primary and secondary education, although some percentage (0 – 20%) do not have any formal education. Extension services can leverage on this profile to upscale production of this commodity. Most of the people involved in this activity have household size of 6 – 9 which can provide reasonable labour force for the execution of ginger production activities.

Experience, Hectarage and cropping system

Table 2 shows that most of the respondents are 6 – 10 years old in ginger production inall the districts surveyed. Their perseverance in ginger production may be an indication that its production has proved beneficial to them over the years. Apart from Mbaazagee, all the districts surveyed have their farm size ≤ 1.5 ha. In Mbaazagee district, 70%, 20% and 10% of farmers have their farm size in the range of ≤ 1.5ha, 1.6 – 2.5ha and 2.6 – 3.5ha respectively. Since production is mainly manual and exclusively dependent on family labour, their small farm size is understandable. In terms of cropping system, 80 – 100% of respondents cultivate ginger as sole crop in open fields while a small percentage (20%) in Mbaazagee cultivate ginger under tree shade. Intercropping ginger with arable crops is not practiced at all. In India,

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growing ginger under tree canopy enhanced rhizome yield compared to growing under open field conditions. It also reduced disease incidence (Tabin *et al* 2014). In Nigeria, Nwaogu *et al.,* (2014) found reduced ginger yield under oil palm plantation but the occurrence of yellow leaf spot disease was delayed and significantly reduced. It is apparent that ginger producers in Buruku Local Government Area are not yet aware of the benefit of cultivating ginger under tree canopies. This aspect may prove beneficial as tree crop farming is widely practiced among the populace (Wikipedia, 2018).

Ginger Varieties and Seed Rhizomes

Table 3 present a summary of ginger variety and seed rhizomes and related attributes as it pertains to the survey area. The variety planted by all the farmers is the black ginger. This is also known as UGII or "Monkey fingers". It is more pungent than the yellow ginger(elephant foot) but yield slightly less. This means that farmers in the surveyed area may be getting less financially because of lower yield of this variety as pungency may not necessarily attract higher prices.

All the farmer's agreed to have obtained their rhizome sets from fellow farmers. This indicates that they want a seed source they could trust. None had their seeds from a research institute which demonstrates that research institutes need to do more to increase the radius of their impact.

It is interesting that all the respondents have their seed rhizomes weight in the range of 20 – 30g. This is the minimum weight of ginger recommended for planting. While Zanil (2015), recommends this rate, Valenzuela (2008) recommends something higher,115 – 230g. The fact that majority of the farmers ensure that each of the rhizomes setts has 2-3 eye buds means they are aware of the implication of such in successful ginger production and might havegained this knowledge from practical experiences. Research is however needed to determine whether the adopted seed size or something higher, will do better.

Fertility Management

Fertility management practices adopted by farmers in the surveyed area are shown on Table 4. All the respondents apply inorganic fertilizers on their farms. Discussion with them indicated that the fertilizers applied were either Urea and or NPK. Most of them apply between 1-3 bags of 50kg (50 – 150kg) and this is applied through broadcasting. Organic manure or inorganic fertilizers are normally recommended, soil incorporated, for ginger production. Broadcasting of fertilizers, particularly Urea, could subject it to volatilization loses or wash off by heavy rains. Although farmers complained of not having access to enough quantities of organic manure, they need to be sensitized to its benefits. This may stir them to make more effort at accessing such given that their farm lands are small, and could make organic matter application less tasking. This is even more justifiable given that none of the respondents is leaving their land to fallow. This is a pointer to greater pressure on land which could lead to land degradation if not properly managed as by way of application of organic inputs.

Mother Rhizomes Removal

All the farmers interviewed agreed that at some point after planting they remove the mother rhizomes (planted rhizomes) for economic purposes (Table 5). In majority of the cases, this removal is done 2 months after planting, while in very few cases (20% at Mbaade), it is done three months after planting. It is obvious that after planting, there is scarcity of ginger in the market and a concomitant rise in price. It is therefore tempting to remove the mother rhizome for sale at this point.While it may make economic sense to do this, the influence of this activity on growth, yield and quality of the growing crop or even

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the quality of the old rhizome been offered for sale needs to be investigated.

Crop Harvest, Yield, Storage and Income.

Table 6 presents a summary of responses by ginger farmers in the surveyed districts with respect to harvest, yield storage and gross income realized from ginger sales. All the farmers harvest their crop within one year of planting contrary to the practice elsewhere,where for certain reasons farmers could leave their crop on the field for the next cropping season.

Most of the farmers place their harvested rhizomes in bags or pits and keep under cool conditions without adverse effects. It needs to be tested whether the particular ginger variety cultivated by farmers in the surveyed location is hardy and therefore amenable to such casual storage conditions. Most of the respondents got yield of 100 – 5000kg of fresh rhizomes except at Mbaazagee where higher yields were obtained. Incidentally, this district devotes higher land area to ginger cultivation than the rest (Table 2). Similar trend is discernible in terms of gross income realized, with majority of the respondents, realizing between #100,000 and #300,000 in 2017. Some farmers from Mbaazagee district normally realize a higher income than that. Thus, owing to the land area devoted to the crop and the income realized, it can be infered that ginger production is a profitable enterprise.

Challenges

All respondents were unanimous that the challenges they faced in ginger production are finance, input and marketing (data not shown). They did not consider labour, storage, pests and diseases asproblems. This shows that with encouragement from relevant quarters, ginger production can be boosted tremendously as at present the crop is yet to be encumbered with series of problems.

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Table 1: Demography of Ginger Producers in Buruku LGA of Benue State

Feature	Council Wards				
	Mbaazagee	**Mbakula**	**Mbatyough**	**Mbaade**	**Shorov**
Age					
20 – 39	0	0	0	0	0
40 – 59	10	30	20	10	20
60 – 79	60	50	60	60	70
80 – 89	30	20	20	30	10
Total	100	100	100	100	100
Gender					
Male	60	40	70	50	50
Female	40	60	30	50	50
Total	100	100	100	100	100
Marital Status					
Married	100	100	100	100	100
Single	0	0	0	0	0
Divorced	0	0	0	0	0
Widowed	0	0	0	0	0
Total					100
Household size					
1 - 5	0	10	20	20	10
6 - 9	60	60	80	70	40
10 - 14	30	10	0	10	30
15 - 19	10	20	0	0	20
Total	100	100	100	100	100
Educational Background					
Primary School	20	50	50	40	30
Secondary School	50	30	40	40	30
Tertiary	30	0	10	0	20
None	0	20	0	20	20

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Table 2: Experience ofRespondents, Hectarage and Cropping System adopted by Ginger Farmer in Buruku LGA of Benue State

Feature	Council Wards				
	Mbaazagee	Mbakula	Mbatyough	Mbaade	Shorov
Experience , ..m .. mmm./. (Years)					
1 – 5	0	10	20	20	10
6 – 10	60	60	80	70	40
11 – 15	30	10	0	10	30
≥ 16	10	20	0	0	20
Hecturage					
≥ 1.5	70	100	100	100	100
1.6 – 2.5	20	0	0	0	0
2.6 – 3.5	10	0	0	0	0
≥ 3.6	0	0	0	0	0
Cropping System					
Under tree shade	20	0	0	0	0
Intercrop with arable crops	0	0	0	0	0
Sole ginger in open field	80	100	100	100	100

Table 3: Ginger Varieties, Seed Source and See Attributes of Planted Ginger

Attribute	Council Wards				
	Mbaazagee	Mbakula	Mbatyough	Mbaade	Shorov
Ginger Variety					
Black Ginger	100	100	100	100	100
Yellow	0	0	0	0	0
Seed Source					
Market	0	0	0	0	0
Own seed	0	0	0	0	0
Research Institute	0	0	0	0	0
Fellow farmers	100	100	100	100	100
Weight of rhizomes (g)					
20 – 30	100	100	100	100	100
31 – 40	0	0	0	0	0
41 – 50	0	0	0	0	0
≥ 51	0	0	0	0	0
No of eye buds on Setts					
One	0	0	10	0	0
Two	20	90	60	70	70
Three	80	10	30	30	30
Four	0	0	0	0	0

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Table 4: Fertilizer Management as Performed by Respondent in Buruku LGA of Benue State

Attribute	Council Wards				
	Mbaazagee	Mbakula	Mbatyough	Mbaade	Shorov
Type pf Manure applied					
Inorganic	100	100	100	100	100
Organic	0	0	0	0	0
Other(s)	0	0	0	0	0
Quantity applied					
1 – 3 (50- 150kg)	60	100	100	100	100
4 – 6 (200-300)	40	0	0	0	0
≥ 7 (350kg)	0	0	0	0	0
Method of application					
Broad casting	100	100	100	100	100
Side placement	0	0	0	0	0
Ring method	0	0	0	0	0
Natural fertility restoration					
Fallow	0	0	0	0	0
Rotation	50	30	10	0	70
Continues cropping	50	70	90	100	30

Table 5: Removal of Mother Rhizome by Farmers in Buruku LGA of Benue State

Attribute	Council Wards				
	Mbaazagee	Mbakula	Mbatyough	Mbaade	Shorov
Rhizome					
Yes	100	100	100	100	100
No	0	0	0	0	0
Reason for Removal					
Sale	100	100	100	100	100
Consumption	0	0	0	0	0
Time of Removal (Months after planting)					
One	0	0	10	0	0
Two	80	90	90	80	100
Three	20	10	0	20	0
Four	0	0	0	0	0

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Table 6: Ginger Harvest Yield Storage and Income Realized by Farmers in Buruku LGA of Benue State

Attribute	Council Wards				
	Mbaazagee	Mbakula	Mbatyough	Mbaade	Shorov
No of years before harvest					
One	100	100	100	100	100
Two	0	0	0	0	0
Storage Method					
Bags	50	10	30	0	20
Pits	50	90	70	100	80
Floor	0	0	0	0	0
Other	0	0	0	0	0
Yield (kg/ha, in 2017)					
100 – 5000	10	100	100	80	100
5100 – 10,000	40	0	0	20	0
10,100 – 15,000	0	0	0	0	0
15,100 – 20,000	10	0	0	0	0
≥ 20,100	40	0	0	0	0
Income from sales (₦'000)					
100 – 300	50	100	90	100	100
301 – 600	20	0	10	0	0
601 – 900	10	0	0	0	0
≥ 901	20	0	0	0	0

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Participatory Rural Appraisal of the Impact of Bacterial Blight Disease on Cowpea Production: Implications for Breeding for Resistance

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Abstract
Cowpea yield per unit area cultivated in Nigeria continues to reduce despite the increase in the land area under cultivation. Bacterial blight disease of cowpea (CoBB) caused by Xanthomonasaxonopodispvvignicolahas been found to be an important disease of cowpea reducing yield to about 64-100%. Involving farmers in the process of developing resistant varieties is important in order to meet farmer's needs with regards to production.We studied the impact of bacterial blight disease on cowpea production in Niger State, Nigeria using semi-structured questionnaires to interview 150 farmers in Tatabu and Mokwa Central of Niger State focusing on (i) farmers' knowledge on the symptoms of the disease (ii) effect of the disease on cowpea harvestable parts (iii) preferred traits and other production constraints. High grain yield followed by resistance to pest and diseases top the priority list of preferred traits by farmers. Bacterial blight disease affects foliage, pods and the grains thus reducing farmers' income. Owing to the limited knowledge of the farmers about available resistant varieties, farmers use pesticides to manage the disease. To enhance cowpea production and adoption of developed resistant cowpea varieties to CoBB, it is important to involve the farmers from the design to varietal selection, considering their preferences, strengthen seed multiplication and dissemination of improved varieties.
Keywords: *Bacterial blight; cowpea breeding; cowpea farmers; participatory rural appraisal; resistance*

INTRODUCTION

Cowpea [*Vignaunguiculata*. (L.) Walp.] is one of the important food legumes providing more than half the plant protein in human diets with cowpea grain containing about 25% protein (Bressani, 1985).Out of the 12.5 million hectares (ha) cultivated to cowpea worldwide, about 10.4 million ha are in West and Central Africa, distributed predominantly between Nigeria and Niger. Nigeria produces the highest cowpea grains of about 2.5million tonnes making her the largest world producer (FAO, 2012). In spite of the fact that realized grain yields are low (0.781Kg/ha) compared to the cowpea potential yield of 4,000kg/ha (Singh and Ajeigbe, 2001;Ajeigbe et al., 2008), cowpea has continued to be a popular crop among farmers because it provides high protein food for people, especially children; it improves and sustains soil fertility, and provides high quality fodder for livestock (Tarawali et al., 1997; Singh and Tarawali 1997). As one of the first crops to be harvested each season, it contributes to household food security during the pre-harvest period when food reserves are low. Sale of cowpea also provides a source of income, not only for

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household needs but also to enable farmers to pay for inputs and labor for the maintenance and harvest of other later-maturing crops. Despite the numerous advantages of cowpea, its production is constantly being faced with biotic and abiotic constraints which include insect pests, parasitic plants, viral, fungal, bacterial diseases, drought, poor soil, acidity and heat (Singh and Ajeigbe, 2001;Ajeigbe et al., 2008). Bacterial blight disease of cowpea (CoBB) caused by *Xanthomonasaxonopodis*pv. *vignicola* (Burkholder) Dye is the most widespread disease of cowpea. It has been reported from all cowpea growing regions of the world. Symptoms start with small water soaked spots on leaves which later coalesce into large brown, necrotic lesions surrounded by yellow haloes. The pathogen invades the stem producing cracking with brown stripes and canker. It produces water soaking on the pods where it enters the seeds and cause seed discolouration. Thus, all harvestable parts of cowpea are attacked by this pathogen with estimated loss ranging from 71%, 68% and 53% for pod, seeds and fodder yield respectively (Okechukwu*et al*., 2004). Disease management methods such as seed treatment with hot water or H_2O_2 and N-heterocyclic pyridinium chlorochromate (PCC), use of chemicals such as bactericides are often expensive and not practicable at a field scale in our environment. Cultivation of resistant cowpea genotypes therefore appears to be a promising strategy to control CoBB as it offers the greatest potential and economic dividend for long-term management of this disease on a large field scale; given the environmental and health concerns associated with the use of chemical insecticides (Emechebe and Shoyinka 1985; Sikirou 1999). Low or no adoptions have been recorded for many improved crop varieties because they often times do not meet the exact needs of the farmers (Nederlof and Odonkor, 2006). In order to enhance adoption of new varieties, farmers have to be engaged early in the development process. The use of methods such as participatory approaches, Farmer Field Schools (FFS) and Participatory Learning and Action Research (PLAR) to engage farmers in problem design, education and experimentation are being used to involve farmers in agricultural development projects (Witcombe et al., 1996; Nederlof and Odonkor, 2006). Involvement of farmers in setting breeding objectives offers the best option of ensuring best varieties that meet the farmers' needs as farmers derive satisfaction from the total package of any new variety as reflected in the overall grain yield, end-user traits and quality which the breeders might not consider if working in isolation. Weltzien*et al.,* (1996) reported that the participatory breeding approach has helped breeders to appreciate farmers' unique requirements and preferences and has resulted in the selection of appropriate crop varieties which were readily adopted by farmers because they had a sense of belonging to the new variety. The aims of this study therefore, were to (i) assess farmers' knowledge on cowpea bacterial blight disease and its impact on productivity (ii) impact of bacterial blight disease on the quality and quantity of grain and fodder yield and (iii) determine other important traits that farmers prefer in improved cowpea varieties.

MATERIALS AND METHODS

A participatory rural appraisal was conducted in the cowpea growing communities of Tatabu (9.23N; 4.92E) and Mokwa Central (9.12N; 5.05E) both in Mokwa, Niger State, Nigeria. These sites receive mean annual rainfall of 1100mm which is adequate for cowpea production in the North central region of Nigeria. Total of 150 famers were interviewed using structured questionnaires. The ratio

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of men to women was 65 to 25 in Mokwa central and 51 to 9 in Tatabu. Male and female farmers were interviewed separately due to religious and cultural beliefs.

Data collection and analysis

Interview guide was used for focus group discussion at the two sites and questionnaires were administered to individual respondents at various locations. Data generated were coded and analyzed using SPSS version 17.0. Chi-square test was used to compare farmers' perception of CoBB between locations. Using a structured questionnaire, questions were put to individual farmers with translators clarifying issues in their local language and enumerators recording the information. The major elements during interviews were: (i) awareness of bacterial blight disease (ii) estimated yield reduction in harvestable parts as a result of CoBB incidence (iii) production constraints and preferred traits in cowpea varieties. Visual aids were provided to help the farmers link their field experience to what was being asked. This helped farmers identify the disease symptoms they have observed on cowpea leaves, pods and seeds.

RESULTS

Farmers educational background and bio-data

Highest percentage of the farmers interviewed had no formal education (55.3%). More males (77.3%) were interviewed than female (22.7%) (Table 1).

Farmers' perception of bacterial blight disease

The symptoms caused by *Xanthomonas axonopodis*could only be identified by 29% of respondents while 28.64% of the farmers were able to associate yield reduction to bacterial blight disease with the help of visual aids provided. Farmers in Mokwa central were more familiar with the symptoms of bacterial blight disease than farmers in Tatabu (Table 2).

Estimated yield reduction on cowpea harvestable parts

35.8% of the respondents agreed to have about 40-60% yield reduction for all the parts; 16% agreed to have yield reduction above 60% while 32% of them were unable to estimate their yield loss (Fig. 1).

Farmers' preferred traits

High grain yield was the most preferred trait in both communities (Table 3). This was followed by resistance to pests and diseases, grain storability and good market value. Farmers particularly stressed their preference for large seeds, which they associate with increased seed weight and higher market prices than small seeds.

Production constraints across both communities

Most farmers (48.7%) indicated the complex interaction of pests and diseases as the major cowpea production constraint (Fig. 2). They particularly reported flower thrips and pod borer as major pests that reduce attainable yield. The most important disease was bacterial blight which was reported to attack all the harvestable parts of the crop at any growth stage of the crop.

DISCUSSION

Bacterial blight disease is a serious disease of cowpea in Nigeria (Okechukwu et al., 2010) although there seems to be a lack of awareness. The farmers were able to clearly identify that bacterial blight disease was the disease they were describing as a serious disease limiting production during the interview with the help of the visual aid provided. The report of Emechebe and Soyinka (1985) confirmed that complete defoliation leading to low yield of susceptible plants can result under heavy epiphytotic. Okechukwu et al., (2000) reported foliage loss due to CoBB seriously affected farmers in the Northern Nigeria who need the leaves as fodder for livestock. Farmers' ranking of insect pests as the major production constraint was as a result of their experiences with flower

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thrips, leaf miners and pod borers whose damages are more noticeable than the bacterial blight disease. Previous researchers reported similar findings that insect pests are major production constraints (Makoi et al., 2010). Yield was ranked first among other traits preferred by farmers to be considered when breeding for resistant/improved varieties. This suggests that farmers will easily adopt any improved variety that can give them higher yields than their local varieties as long as it can combine their other traits of interest. Breeding interventions are the most affordable means militating against this disease because there is potential for inoculum build-up and increased disease severity as a result of successive cropping of susceptible varieties at the same site. Other production constraints to cowpea production such as post-harvest handling and market accessibility mentioned by farmers will require the intervention of other partners in sustainable agriculture.

CONCLUSION

This survey revealed farmers' readiness to pay premium to get resistant varieties that will boost their production and translate to more financial gain to them since all of them cultivate cowpea for both consumption and sale. Since most of their existing varieties are susceptible, the best management approach would be breeding varieties resistant to bacterial blight disease. This will involve sourcing for resistance from germplasm and introgression of the genes into locally adapted variety. Farmer participatory approaches at the beginning of a breeding project would enable breeders to improve the selection procedure by taking into account farmers' preferred traits at an early stage. In this study, all the respondents agreed that farmers' involvement from start to finish in agricultural development projects will better enhance full adoption of any improved varieties.

ACKNOWLEDGEMENT

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Table 1. Farmers' bio-data and educational background

Respondent's age		**Respondent's sex**		**Educational Level**	
Age group (years)	Frequency		Frequency		Frequency
16-35	70 (46.7) *	Male	116 (77.3)	No formal education	83 (55.3)
35-65	72 (48.0)	Female	34 (22.7)	Primary	20 (13.3)
Above 65	8 (5.3)			Secondary	42 (28.0)
				Tertiary	5 (3.3)

* Note: Percentages are put in brackets

Table 2. Incidence and farmers' perception of bacterial blight disease of cowpea in two locations in Niger state

	*Respondents (%)		
Community (n=150)	**Familiarity with CoBB**	**Experienced with CoBB**	**Yield reduction associated with CoBB**
Tatabu (60)	12.52	23.20	22.90
Mokwa central (90)	18.78	34.80	34.38
Average	15.65	29.00	28.64
Chi-square	77.32	4.20	84.30
d.f	2	1	2
Prob.	0.000	0.410	0.000

*Note: Frequencies of respondents who answered 'No' have been omitted, though were catered for in the chi-square value.

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Table 3. Pair-wise ranking of farmers' preferred traits

Traits	Cooking time	Good market value	Yield	Taste	Storability	Disease resistance	Score	Rank
Mokwa central (n=30)								
Cooking time	------------	Good market value	Yield	Taste	Storability	Disease resistance	2	5
Good market value	Cooking time	-----------	Yield	Good market value	Good market value	Disease resistance	3	4
Yield	Yield	Yield	-----------	Yield	Yield	Yield	9	1
Taste	Cooking time	Good market value	Yield	-------------	Storability	Disease resistance	2	5
Storability	Storability	storability	Yield	Storability	------------	Storability	5	3
Pest and Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	-------------	8	2
Tatabu (n=24)								
Cooking time	------------	Good market value	Yield	Cooking time	Storability	Disease resistance	2	5
Good market value	Good market value	------------	Yield	Good market value	Good market value	Good market value	6	3
Yield	Yield	Yield	--------	Yield	Yield	Yield	9	1
Taste	Cooking time	Taste	Yield	----------	Storability	Taste	2	5
Storability	Storability	Good market value	Yield	Storability	-------------	Disease resistance	3	4
Pest and Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	Disease resistance	----------	7	2

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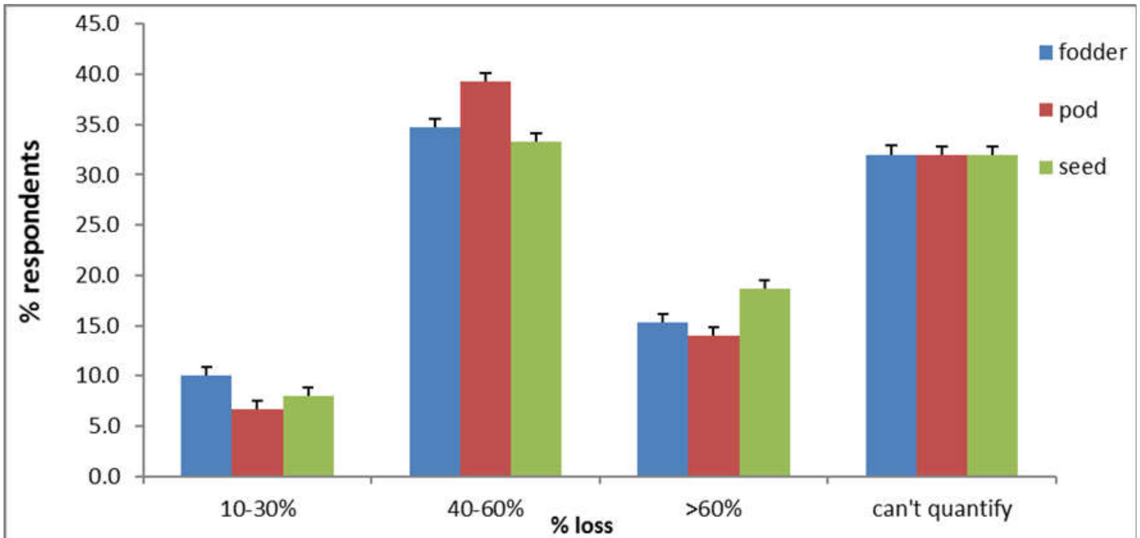

Fig. 1. Estimated loss of cowpea harvestable parts

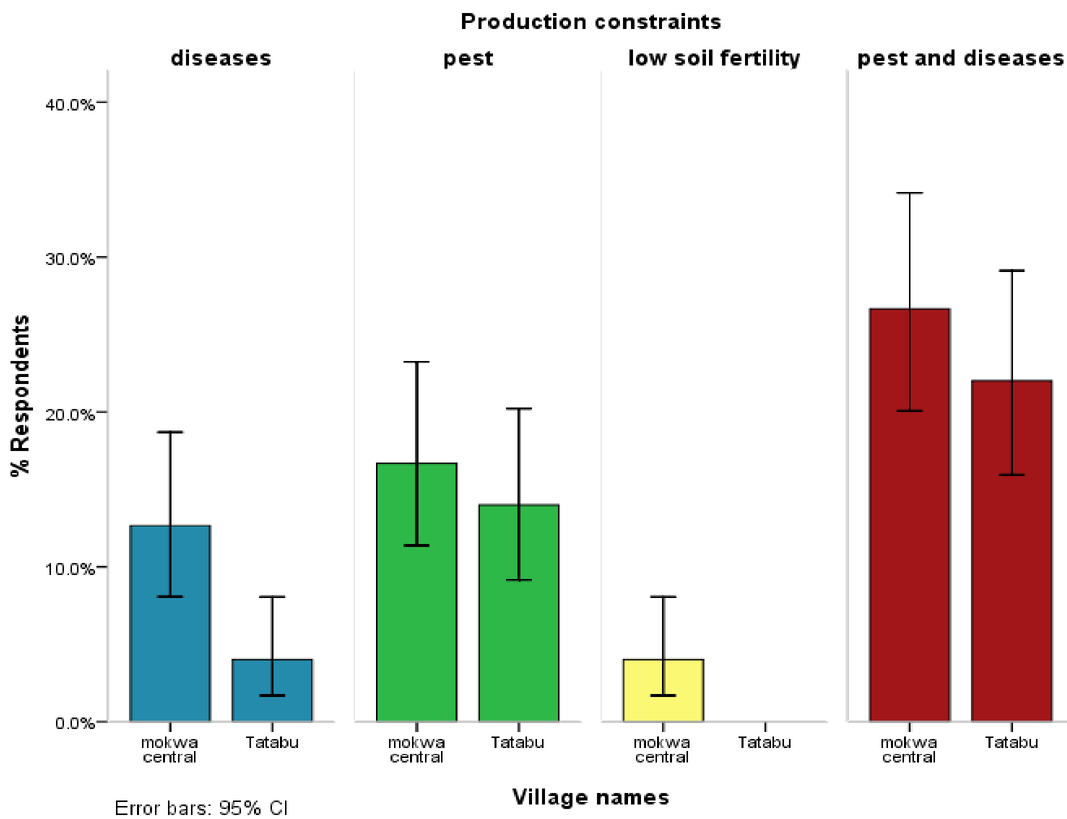

Fig. 2. Constraints to cowpea production

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Profitability and Constraints of Ginger Production by Women Ginger Farmers in Samaru Zone of Kaduna Agricultural Development Project (KADP), Kaduna State.

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Abstract
The study focused on profitability and constraints of ginger production by women ginger farmers in Samaru Zone of Kaduna Agricultural Development Project (KADP), Kaduna State. A multi-stage sampling technique was used to select 205 women ginger farmers. Primary data were collected from 205 women ginger farmers with the aid of structured questionnaire. The analytical tools used to analyze the data were descriptive statistics and gross margin analysis. The Gross Margin (GM) was 4,405,692/h and average rate of return on investment was 4.8.The major constraints identified were high cost of production (4.42), lack of credit (4.3), inadequate improved technology (4.2),inadequate inputs (4.0),poor extension services (3.9) and Problem of transportation(3.9). The study recommended that government and other non-governmental organizations give women ginger farmers the best needed assistance in form of incentives and innovation in ginger production since it is a profitable business.
***Keywords**: Profitability, Returns, Ginger, Women, Constraints.*

INTRODUCTION

Nigeria is basically an agrarian economy with about 85% of the population depending on agriculture. Agriculture is a fundamental instrument for stemming and reversing the worsening poverty, food insecurity and natural resources degradation trends (Asogwa *etal*.,2012). Agriculture provides food, employment to about 75% of nation's population, income to farming households as well as a major source of foreign exchange earnings.

Generally, women play a crucial role in farming and it is estimated that about 60 percent of agricultural production activities are carried out by women in the continent of Africa. Women combine domestic works with subsistence farming, including fishing, processing and sales of agricultural produce. Nigerian women are largely engaged in many sectors of the economy. Women have been found to contribute 60 percent of labour force and produce 80 percent of food (Rahman, 2008).

According to Food and Agriculture Organisation (2008,) India produced 420,000 tons; China 285,000 tons; Indonesia 177,000 tons while Nigeria produced 138,000 tons of ginger annually. Among the crops predominantly cultivated in Southern Kaduna is ginger and is one of the most economically beneficial crops in southern part of Kaduna state.

Ginger (*Zingiberofficinale R.*) cultivation in Nigeria dates back to 1927 and it is believed to have Asian origin. Ginger was introduced to Africa and the Caribbean by the Colonial Masters; and it is now cultivated throughout the humid tropics (KADP, 2000). Ginger is produced in states namely: Kaduna, Nasarawa, Benue, Niger and Gombe with Kaduna as the major producer. Ginger is a commodity that is highly valued in international markets for its aroma, pungency, high oleoresin oil content and also consumed as medicine, or spice. Nigeria produces and export good quality ginger; that contains less fiber which is generally preferred by Western countries. Ginger production, processing and marketing are big businesses that guarantee high returns on investment. For instance, according to a study carried out by National Root Crops Research Institute (NRCRI), for every N1 million investment in ginger production the investor gets ₦2.94 million in return (Isaac, 2015).

There is little information on profitability of ginger production in the study area being the highest producers of ginger in the country and more especially there is little empirical evidence on profitability of ginger production among women ginger farmers.

The objective of the study is to determine the profitability and constraints of ginger production by women ginger farmers in the study area.

MATERIALS AND METHODS

Kaduna State is one of the 36 states in Nigeria. It is made up of 23 Local Government Areas. It is situated between latitude9^{0}2 N, 11^{0}35 N and between longitude 7^{0}15 E and 9^{0}6 . Samaru Zone of Kaduna State Agricultural Development Project (KADP) is located in the southern part. It is made up of seven Local Government Areas: Kachia, Jaba, Kagoro, Jema'a, Zangon Kataf, Kaura and Sanga Local Government Areas.The climate is predominantly tropical with two distinct seasons (dry and wet seasons). Over 75 percent of the active population are engage in farming as their primary occupation. The major cash crop is ginger where commercial quantities are produced annually with Kachia, Jaba, Kagarko, Jema'a and Zangon Kataf Local Government Areas as the major areas of production.

The target population for this study was all the women involved in ginger production in southern zone of Kaduna Agricultural Development Project (KADP). A multi stage sampling technique was used.The first stage involved a purposive selection of two Local Government Areas (LGAs) namely, Jaba and Kachia. The selection was due to high concentration and intensity in ginger production by women in these areas. The second stage involved a purposive selection of three villages from each of the LGAs. This gave a total of 6 villages (Nok, Kuryas, Fai, Jabankogo, Yarbung 1 and Sabon Sarki) villages. In the third stage, a list of ginger farming households from each village was used as sampling frame, from which samples of ginger farmers were proportionately drawn. Finally, 205 women ginger farmers were randomly selected for the study.Primary data were used in this study. The primary data were obtained by the use of structured questionnaire administered to women ginger farmers. Data collected include the costs of inputs (fertilizer, seed, agrochemicals, labour), income from ginger production, constraints encountered by the women ginger farmers. Descriptive statistics: frequency distribution, mean, percentages was used to achieve objective II and Gross Margin was used to achieve objective I.

RESULTS AND DISCUSSION

Costs and Returns per Hectare of Ginger Production

Inputs used in ginger production include; land, seed, fertilizer, herbicides and labour. The mean farm size was 1 hectare. The minimum and maximum land areas were 0.1ha and 3 ha, respectively. The average quantity of seed used by ginger farmers was 3500 kg/ha. The minimum and maximum seed used were 300 kg/ha and 12600kg/ha, respectively. Average fertilizer used by ginger farmers was 583.6kg/ha while the minimum and maximum were found to be 50kg/ha and 4500kg/ha, respectively. Average herbicides used by ginger farmers was 6.4 L/ha while the minimum and maximum were found to be 0 and 25L/ha, respectively. The mean labour recorded is 181man-day/ha while the minimum and maximum were observed to be 15man/days/ha and 644man/days/ha, respectively. This shows that agricultural production in the study area is of small

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scale and labour intensive. The wide variation in input used by the farmers could be attributed to the fact that they differ in purchasing power and size.

The result in table 1 shows the quantities of inputs used and their costs per hectare. These include ginger seed ;3500.6kg/ha with an average market price of 146 per kg (₦ 511087.6 / ha) and it constitutes 55.1% of the total production cost, fertilizer; 583.6kg/ha with an average market price of 131 per kg (₦ 76451.6 / ha) and this constitutes 8.2% of the total cost of production, herbicides ; 6.4L/ha with an average market price of 2155per L (₦ 13792 / ha) and it constitutes 1.5% of the total cost of production. Labour costs comprises land preparation, planting, fertilizer application, weeding and harvesting. The family labour was computed on the basis of opportunity cost in man-days. The wage rate varied according to farm operation performed. An average wage rate of ₦1800 per man-day was used, giving the average labour cost per hectare to be ₦ 325893.00 and this constitutes about 35.2% of the total cost of production.Gross Income (GI) was ₦5, 332,916/ha while the total variable cost (TVC) was 927,224/ha. The Gross Margin (GM) was therefore 4,405,692/ha. The average rate of returns on investment (Return per Naira Invested) was ₦4.8, indicating that for every N1 invested in ginger production a profit of 3.8 kobo was made. High return per naira investment could be attributed to the high prices of ginger during the 2016/2017 planting season. Therefore it can be concluded that ginger production in the study area was economically viable.

Constraints Encountered by Women Ginger Farmers in the Study Area

Table 2 shows the result of constraints encountered by women ginger farmers in the study area. The constraints encountered by the farmers according to the order of prevalence are high cost of production with a weighted mean of 4.4, lack of credit (4.3), inadequate improved technology (4.2), high cost of labour (4.1), inadequate inputs (4.0), problem of transportation(3.9), poor extension services (3.9), lack of training (3.8), lack of improved storage facility (3.8), low prices (2.2) and pest, diseases and weed infestation (2.0). This finding agrees with that of Hyun,(2008), Tekana *et al.,* (2011) and Onuk *et al.,* (2010) who observed that high cost of farm inputs, inadequate capital, high cost of labour, inadequate storage/processing facilities and inadequate extension visits were among the constraints faced by farmers.

CONCLUSION

The average rate of return on investment (return per naira invested) was 4.8. For every 1 invested in ginger production in the study area; a profit of 3.8 kobo was made. Thus, it can be concluded that ginger production in the study area, despite the constraints encountered, was profitable. Therefore the study recommended that government and other non-governmental organizations give women ginger farmers the needed assistance in form of incentives and innovation for ginger production since it is a profitable business.

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Table 1: Cost and return from ginger production per hectare in

Variables	Values	%
A. Variable cost		
i. Seed (kg)	493,829	55.1
ii. Fertilizer (kg)	76,422	8.2
iii. Herbicides (L)	12,389	1.5
iv. Labour (man-days)	325,893	35.2
B. Total Variable Cost(TVC) = (i+ii+iii+iv)	927,224	
C. Gross Income (GI)	5,332,916	
D. Gross Margin (GM) = (GI – TVC)	4,405,692	
E.Return per Naira Invested RNI)(GM/TVC) =	4.8	

Source: Field Survey (2017)

Table 2: Constraints encountered by women ginger farmers

Constraints	Weighted scores						
	SA	A	U	D	SD	WT	MS
High cost of production	475	412	3	8	2	900	4.4
Lack of credit	495	328	27	22	2	876	4.3
Inadequate improved technology	425	360	48	20	4	857	4.2
High cost of labour	360	448	24	10	4	846	4.1
Inadequate input	340	416	48	24	5	833	4.0
Problem of transportation	280	416	105	4	3	818	3.9
Poor extension services	380	336	39	38	13	806	3.9
Poor storage facility	225	460	75	32	4	764	3.8
Lack of training	265	420	51	32	14	782	3.8
Low prices	165	8	33	162	88	456	2.2
Pests, diseases and weed	25	116	30	224	5	400	2.0

SA = Strongly agree, A = Agree, U= Undecided, D = Disagree, SD= Strongly disagree
WT= Weighted total, MS= Mean score
Decision Rule; any constraint with mean score greater than or equal to 3.5 is significant.
Source: Field Survey (2017)

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Perception of Agricultural Students of Selected Tertiary Institutions on Excursion to National Horticultural Research Institute about Horticulture

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Abstract
The study assessed the perception of agricultural students from selected tertiary institutions on excursion to the National Horticultural Research Institute, Ibadan about horticulture. Purposive sampling technique was used. Three out of the agricultural-based tertiary institutions that visited the Institute on excursion in the third quarter of 2018 were purposively selected. This is due to their related background which is Agricultural Education, Extension and Communication. Questionnaire was used to elicit information from 78 respondents. The students visited all research programmes and units in the Institute. Data collected were analyzed using descriptive statistics. The horticultural research programmes of highest interest to the students were Citrus (26.9%), Processing (15.4%) and Floriculture (15.4%) however, few indicated interest in Genetic resources and Fruits (1.3%), Farming systems and Spices (2.6%), Extension and Biotechnology (5.1%). Most of them (61.5%) were willing to choose a career in horticulture,theywere favorably disposed towards horticulture as a means of improving nutritional content of food ($\bar{x}$ = 4.49), enhancement of environmental sustainability ($\bar{x}$=4.31) and its therapeutic roles ($\bar{x}$ =4.29). They were unfavorably disposed on awareness of horticulture ($\bar{x}$ =3.27) and achieving gender equity through the field of horticulture ($\bar{x}$=3.78). The mean score of the students' responses was 3.80±0.48. Generally, 57.7% were positively disposed towards horticulture generally. The findings of this study therefore calls for increased awareness of horticulture among the students especially in the aspects of biotechnology, genetic resources, seed technology, farming systems and extension to arouse their interest.
Keywords: *excursion, youth-in-horticulture, interest, career.*

INTRODUCTION

The future of Nigeria lies in the participation of its youths (aged between 18-35 years) in agriculture. These youths constitute two-thirds of the population and are found in tertiary institutions across the country (Edozien, 2002).Specifically, Prof. Rod Drew, noted that "Agriculture supplies protein, it supplies carbohydrates, it supplies staple crops - but we'd have a pretty boring life without horticulture, horticulture gives colour, horticulture gives us the flavours, it gives us all the health benefits of a balanced diet"(International Society for Horticultural Science, 2015). Horticulture is a sector withunique attributes which makes it imperative for consideration as an integrative discipline that should develop its specific brand aside agriculture (Hewett, 2015). It is capable of generating local employment, reducing food transport cost and production as well as contributing to environmental sustainability by recycling urban waste, among others (FAO, 2012).

There are few tertiary institutions offering courses in horticulture, several countries having schools/faculties of agriculture have been subsumed by the life or earth sciences (Borgers,2006) . Thus, horticulture is not left to be a major area of study but is given attention when other specific crops are being taught. In Nigeria there are about twelve accredited polytechnics/colleges (Hot School News, 2018) where Horticulture is being taught as a course with only 2 Federal Universities offering the course (Nigerian Scholars, 2018). Smith (2014) opined that the perception of horticulture is increasingly negative and mostly limited because. ''The horticultural industry does not effectively and positively sell itself generally to the broader community, and more specifically to parents, guidance officers/career counselors and students. A whole-of-horticulture promotional/public relations campaign is clearly needed to achieve this purpose'' (Stone et al., 2005) (Meyer et al, 2016 pp 114).

Sharf (1997) defined career choice as follows "applies to decisions that individuals make at any point in their career about particular work or leisure activities that they choose to pursue at that time" (Zotorvie, 2016 pg 259). The choice of a career has influence on an individual's future considering their income, security and job satisfaction as well as life style (Saliu et al, 2016). Previous studies on career perception have been on agriculture (Fraze et al, 2011 and Saliu et al, 2016) and not horticulture.

As a result of the fore-going, it is imperative to examine the perception of agricultural students about horticulture. Specifically, the study:

- Identified areas of students' interest in horticulture
- Profiled students' choice of career in horticulture
- Analyzed the perception of male and female students on the benefits or otherwise of horticulture

METHODOLOGY

Purposive sampling technique was used.Three agricultural-based tertiary institutions visited the Institute on excursion in the third quarter of 2018. Two out of the threeinstitutions were purposively selected due to their related background which is Agricultural Education, Extension and Communication. Ninety-eight questionnaires were given to all the students but only 78 of them were viable and analyzed.The students visited all research programmes and units in the Institute.Data collected were analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Personal characteristics of students

The results showed that 66.7% of the respondents were within 20-29 years age range with mean age of 21.1±3.9,61.5% and 83.3% of the students were male and single respectively. Thus making the study to be in-line with the National Bureau of Statistics, in 2012 which stated that there were about 167 million people in Nigeria with about half of the population being youth (15-34 years of age) (NPC, 2013). For most of the students (93.6%), the one-day excursion was their first time of visiting NIHORT. Visitation to NIHORT will also afford students opportunity of observing horticultural crops on the field, increase their knowledge as well as appreciate the inherent benefits through interaction with researchers and field staff.

Agricultural students' areas of interest in horticulture

The highest group of students (26.9%) indicated interest in Citrus, followed by processing and floriculture (15.4%) respectively, vegetable (11.5%), seed technology (10.3%) (Table 2). Interest of the student in Citrus research programmecould be due to the fact that citrus fruits are part of the most common fruits in the study area and a front-liner horticultural crop. Ibeawuchi et al, (2015) noted that major fruits produced in Nigeria are citrus, mango, pawpaw, plantain/banana, pineapple, guava. Interest of students in processing and floriculture is next to citrus. This could be as result of the fact that processed horticultural products such as juices, jams and marmalades are mostly consumed by youths. Also, floriculture could be practiced in urban areas with little space and the drudgery involved is not as much as other areas. In all areas considered less than half of the students' population indicated interest in the different aspects of horticulture with genetic resources and Fruits (1.3%), biotechnology and extension (5.1%)and farming systems and Spices (2.6%)

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lagging below the ladder. However, these areas with very few students showing interest are very important if agriculture must move forward in Nigeria. Genetic resources and biotechnology as well as extension personnel are greatly needed. Presently at the institute and most research institutions in the country, these same areas are poorly staffed. This is an indication that more awareness and sensitization should be created to arouse students' interest in these areas to. This could be enhanced by creating conducive environment for learning the necessary skills needed in all areas of horticulture.

Agricultural students' choice of career in horticulture

Almost two-thirds (61.5%) of the students are willing to have a career in horticulture, despite the fact that they are already pursuing a course in agriculture (Table 3). This could be due to the interest they have indicated in some aspects of horticulture – Citrus, Floriculture, Product development, among others. Their choice of career in horticulture is particularly encouraging at this period when the country is gearing efforts towards agricultural diversification. The personal interest of students has been observed to be the most important factor that influences career choice (Edwards and Quinter, 2012). Once interest is developed from within, an enabling environment will enhance sustainability of agricultural career especially when it is viewed as a business.

Perception of Agricultural students about horticulture

Students strongly agreed that horticulture is critical in improving nutritional content of food (53.8%), enhancement of environmental sustainability (46.2%) and a profitable and satisfying job (42.3%) (Table 4). In the same vein, 70.5% of them agree that there is limited awareness of horticulture in Nigeria, horticulture plays a greater role in therapy (57.7%), enhances food security (47.4%) and can be used to tackle sustainable development goal of health for all (44.9%). Almost half (47.4%) of the students also disagreed that horticulture cannot be used to enhance environmental sustainability, involvement in the business of horticulture cannot enhance food security (44.9%), among others. Furthermore, the mean score of the students' responses was 3.80±0.48 while 57.7% of the respondents were positively disposed towards horticulture. Specifically, most of the students were favorably disposed towards horticulture as a means of improving nutritional content of food (4.49), enhancing environmental sustainability (4.31), playing greater role in therapy (4.29) and enhancing food security (4.24). They are also unfavorably disposed to the statements that horticulture cannot be used to tackle sustainable development goal of health for all (3.71) gender equity could be achieved through horticulture (3.78).

CONCLUSION

Research programme of interest to most of the students were Citrus, Processing and Floriculture. Students were willing to choose a career in horticulture and were favorably disposed towardshorticulturehowever, they had limited awareness of horticulture. For horticulture to improve food security and promote sustainable environment and national economic growth, there should be increased awareness of horticulture among the youth especially in the aspects of biotechnology, genetic resources, seed technology, farming systems and extension.

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Table 1: Personal characteristics of students

Characteristic	Frequency (Percentage)	Mean (standard deviation)
Sex		
Male	48(61.5)	
Female	30(38.5)	
Marital status		
Married	7(8.2)	
Single	70(82.4)	
Didn't respond	8(9.4)	
Age		21.1(3.9)
<20 years	15(17.9)	
20-29 years	52(66.7)	
>29 years	1(1.3)	
No response	11(14.1)	
First visit to NIHORT		
Yes	73 (93.6)	
No	5(6.4)	

Table 2: Areas of Agricultural students' interest in horticulture

Programme/ Unit	Frequency	Percentage
Citrus	21	26.9
Vegetable	9	11.5
Processing	12	15.4
Floriculture	12	15.4
Seed technology	8	10.3
Genetic resources	1	1.3
Fruits	1	1.3
Biotechnology	4	5.1
Farming systems	2	2.6
Spices	2	2.6
Extension	4	5.1
No response	2	2.6

Table 3: Agricultural students' choice of career in horticulture

Choice of career in horticulture	Frequency	Percentage
Yes	48	61.5
No	25	38.5

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Table 4: Perception of Agricultural students about horticulture

Statement	Strongly agree	Agree	Undecided	Disagree	Strongly disagree	Mean
Horticulture is critical in improving nutritional content of food	42(53.8)	33(42.3)	2(2.6)	1(1.3)	-	4.49
Horticulture is not relevant to improve the nutritional content of food	5(6.4)	6(7.7)	4(5.1)	33(42.3)	30(38.3)	3.99
Horticulture plays greater role in therapy	28(35.9)	45(57.7)	5(6.4)	1(1.3)	-	4.29
Horticulture has no relationship with therapy	3(3.8)	10(12.8)	12(15.4)	33(42.3)	20(25.6)	3.73
There is awareness of horticulture in Nigeria	10(12.8)	28(35.9)	19(24.4)	15(19.2)	6(7.7)	3.27
There is limited awareness of horticulture in Nigeria	16(20.5)	55(70.5)	3(3.8)	4(5.1)	-	1.94
Horticulture could not be used to tackle sustainable development goals of health for all	6(7.7)	11(14.1)	8(10.3)	28(35.9)	25(32.1)	3.71
Horticulture could be used to enhance sustainable development goal of health for all	33(42.3)	35(44.9)	5(6.4)	3(3.8)	2(2.6)	4.21
Horticulture could not be used to enhance environmental sustainability	5(6.4)	6(7.7)	11(14.1)	37(47.4)	19(24.4)	3.76
Horticulture could be used to enhance environmental sustainability	36(46.2)	35(44.9)	4(5.1)	1(1.3)	2 (2.6)	4.31
Gender equality could not be achieved through the field of horticulture	5(6.4)	17(21.8)	19(24.4)	25(32.1)	12(15.4)	3.28
Gender equality could be achieved through the field of horticulture	21(26.9)	29(37.2)	19(24.4)	8(10.3)	1(1.3)	3.78
Horticulture is not a profitable and satisfying job	3(3.8)	9(11.5)	5(6.4)	33(42.3)	28(35.9)	3.95
Horticulture is a profitable and satisfying job	33(42.3)	32(41.0)	5(6.4)	5(6.4)	3(3.8)	4.12
Involvement in horticulture business cannot enhance food security	7(9.0)	7(9.0)	5(6.4)	35(44.9)	24(30.8)	3.79
Involvement in horticultural activities can enhance food security	31(39.7)	37(47.4)	8(10.3)	2(2.6)	-	4.24

Figures in parentheses are percentages

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Effect of Capacity Building Training Workshop on Participants' Knowledge of Production Techniques in Ginger and Turmeric in Ibadan Metropolis, Oyo State, Nigeria

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Abstract
Ginger and turmeric rhizomes are among cultivated spices of economic, nutritional and health importance globally. Exploiting these potentials requires improvement and update offarmers'technical knowledge throughtraining. The study evaluated effect of training activity on participants' knowledge in ginger and turmeric production technique. Oyo state was purposively selected to complement training programme on ginger and turmeric processing for selected stakeholders in the state in 2017. Participants were drawn from farmers' organization, Oyo state Agricultural Development Programme, women and youth groupsin Ibadan metropolis. Structured questionnaires were used to collect data from 52 respondents.Participants' knowledge on ginger and turmeric before and after training was determined. Descriptive and inferential statistics were used to analyze collected data. There were 57.7% male, 73.1% married and36.6% were within 30-40 years old.Majority (80.8%) ofthe respondents were educated with tertiary education.Most of the respondents confirmed no previous experience in ginger (75.0%) and turmeric (80.8%) production. Only 17.3% ofwerepreviously involved in ginger and turmeric production. Few respondents agreed that ginger (15.4%) and turmeric (13.5%) are of high economic value. Ginger production is for home consumption in fresh and processed form (11.6%) and home consumption in fresh form only (5.8%). Turmeric production was for home consumption in dried and fresh form (13.5%).Pre and post knowledge mean score was 9.50±5.42 and 10.15±4.95 respectively. T-testresult shows a significant difference (t = 14.56, p = 0.00) in participants' knowledge after training.Training of horticultural stakeholders is germane to improved knowledge, enhanced food security and economic growth.

Keywords:*Capacity building, stakeholders, ginger, turmeric*

INTRODUCTION

Ginger and turmeric belong to the group of plants referred to as spices. Spices are condiments of plant origin consisting of parts of trees, seeds, shrubs and grass which abound in the tropical rainforest and savannah grassland zones. Nigeria is blessed with a rich ecosystem that has the potential for production of typical spices (Fasola, 2000).The most widely utilized plant species in Nigeria are the spices. These species are the major sources of powder and or seeds used in cooking and have strong taste and smell (Schippers, 2000). They are often referred to as food accessories or adjuncts used principally to spice food, drinks and as medication for various ailments (Ogunka-Nnoka*et al*.,2012). In Nigeria, spices are mostly obtained from the wild while others are cultivated. Those from the wild includes *Piper guinensis, Monodora myristica, Tetrapleura tetraptera, Xylopia aethiopica, Aframomum melegueta.* Ginger, turmeric, onion, garlic and basil are among the cultivated spices in Nigeria and both haveexport potentials.

Ginger (*Zingiber officinale* Linn) and Turmeric (*Curcuma longa* Linn) are both rhizomatous perennial plants of the ginger family, Zingiberaceae. Ginger grows in warm and humid climate under rain fed and irrigated conditions. It thrives in well drained soils such as sandy or clay loam, red loam or lateritic loam with pH between 5.5 and 6.5 (Vasundhara, Rao and Nuthan, 2011). Turmeric also grows in diverse tropical conditions. It thrives best in drained sandy or clay loam soils with temperature ranging between 20 – 30 ^{o}C

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(Akinpelu, Adebayo, Adewale*et al*., 2012).Production of ginger and turmeric is a viable diversification enterprise for small-scale farmers in south western Nigeria considering the amiable agro-ecology, trade opportunities and promising income generating potentials. They can be successfully cultivated with minimal inputs of cash, labour and land and their production can offer additional employment opportunities within the household where income earned can be available in times of need or shortageto supplement household income. Ginger and turmeric are also ideal crops that can be integrated into small-scale farming systems or home gardens (Mathews and Jack, 2011). They are high value commodities that can make substantial impact on the economic status of farmers, processors and industrialists. Relevant stakeholders need to be encouraged to move from subsistence level of spice production to commercial scale so as to harness the inherent potentials in Nigeria.

There is good trade potential for ginger and turmeric as well as their products. Ginger and turmeric producers can therefore take advantage of market available for fresh, dried, granular and value added products to enhance their income and livelihoods. Advances in medicinal crops research have also revealed the novel uses of both crops with promising potentials in the prevention, management and treatment of several diseases such as diabetes, cancers, bronchitis, as well as various pharmacological activities including antioxidant, antiviral, anti-inflammatory, anti-bacterial (Ram *et al*, 2011).Turmeric is used as dye, medicine and flavour, to treat stomach and liver ailment and heal sores (Vinod, 2013) while ginger relieves nausea, aids digestion, home remedy for nausea and reduces inflammation (Megar, 2017). Despite the multifaceted uses of these spices, they are still classified as neglected or endangered species, in view of the fact that they are not regularly cultivated like most food crops in Nigeria (Adelaja, 2005).

Ginger and turmeric are mostly grown in the northern part of Nigeria, there is the need to spread production of the two commodities to other parts of the country to fully exploit the economic potential and health benefits across the country. The favourableweather conditions in south west Nigeria could be harnessed to enhance farming households income and improve their livelihoods. It is important to explore the huge potentials embedded in ginger and turmeric production as high value, low volume crops across the country.The starting point is to train prospective farmers to improve their knowledge in the production of the commodities. The study examined the effect of capacity building training workshop on participants' knowledge of production technique in ginger and turmeric production in Ibadan metropolis of Oyo state. The specific objectives are to:

i. determine the socio-economic characteristics of respondents
ii. ascertain the production status of trainees
iii. determine the inherent and acquired knowledge of trainees in ginger and turmeric production techniques
iv. Examine the difference between trainees' pre-training and post-training knowledge of ginger and turmeric production.

METHODOLOGY

Oyo state was purposively selected to complement a training programme on ginger and turmeric processing for selected stakeholders in the state in 2017. This is to have a complete package of recommendations across the commodities value chain. Participants were drawn from farmers' organization, women, youth

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group and staff of the Oyo state Agricultural Development Programme.This is to promote training of trainers' concept to ensure wide spread and diffusion of training knowledge. Items were drawn on technical knowledge of participants about ginger and turmeric production. Mean score before and after training was determined. Questionnaire was used to collect data from respondents. Both descriptive and inferential statistic were used to analyze the data collected. A total of 78 stakeholders participated in the training while 52 useful questionnaire were analyzed.

RESULTS AND DISCUSSION

Personal characteristics of respondents

There were 57.7% male and 42.3% female, 32.7% and 23.1% were within 51-60 and 41-50 years old respectively. A cursory look at the result shows that greater proportion of respondents were within 30-40 years old. Greater proportion of the respondents had varying level of education ranging from tertiary (80.8%) and secondary (7.7%) education.Educational level of the farmers may improve their level of adoption of agricultural innovations. Ezra et al (2017) also found that 68% of farmers at Kaduna had tertiary level of education and had 1-10 years of farming experience in ginger production (38.3%). About 73.1% were married, 30.8% had 1-4 children while 78.2% had between 4-8 children. Major occupation of respondents include farming (46.2%), civil servant (21.2%), trading (11.5%) and unemployed youth (15.4%) and majority had 1-10 years of experience in farming while 71.2% belong to different associations(Table 1). This is similar to the findings of Ezra et al, 2017,they found that 83.3% of farmers involved in Ginger production in Jaba local government area of Kaduna state were male and married (85%) thus indicating dominance of men in ginger production.

Ginger and turmeric production among respondents

Considering ginger production among respondents, 17.3% were involved in ginger production before the training and had less than one hectare(Ezra et al, 2017 also found that average farm size employed by ginger farmers in Jaba local government area of Kaduna was 1.19ha., only 15.4% perceived that it is of high economic value probably because many of them have not started production. However, Ihuoma and Dogara (2018) reported that ginger is capable of providing income and alleviation of poverty in their study in Kaduna. Purpose of ginger production for the few that were involved include home consumption in fresh and processed form (11.6%) and home consumption in fresh form only (5.8%). Few (17.3%) respondents were involved in turmeric production before the training and 11.5% had less than 1ha and 13.5% perceived it is of high economic value. Purpose of turmeric production were home consumption in dried and fresh form (13.5%). (Table 2). The proportion of respondents that were involved in production before training and their perception about its economic value is an indication that few were aware of the inherent potentials of these commodities.

Pre and Post training knowledge assessment of participants

Inherent knowledge of trainees was reflected in their pre knowledge mean score of 9.50±5.42 while post knowledge mean score of 10.15±4.95 reflected the additional knowledge acquired after the training. This is an indication of increase in knowledge among respondents after exposure to the trainingprogramme.

Test of difference between pre and post-training knowledge of ginger and turmeric production techniques among trainees

Result of the t-test also shows a significant difference ($t = 14.56$, $p = 0.00$)

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in participants' pre and post knowledge score at 5% confidence level (Table 3). The result of the T-test further confirmed that participants' knowledge increased after the training workshop. Participation in training workshop is one of the avenues for effective dissemination and adoption of horticultural and avgricultural technologies technologies at large. Training is needed to better equip stakeholders in good agricultural practices and appropriate skill acquisition.Candice (2018) stressed that knowledge of improved quality is capable of improving products value internationally. Increased knowledge of production technique through appropriate training couldalso enhance quality of the final products. Thus improved product quality could be traced to improved production technique through capacity building activities.

CONCLUSION AND RECOMMENDATION

Most of the respondents wereeducated, with 80.8% tertiary education, young and agile, majority belong to one association or the other, had little experience in ginger and turmeric production and unaware of the prospects in the production of the crops. Production presently among respondents were mainly for home consumption.Participants' youthful age, education and membership of association are available strength that could enhance entrepreneurship development in the selected commodities. Participants should be properly followed up and encouraged with more advisory services for effective take-off and sustainability.

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Table 1: Frequency distribution of the personal characteristics of respondents

Variables	Items	Frequency	%
Age of respondents	<&equal to 30	8	15.4
	31-40	11	21.2
	41-50	12	23.1
	51-60	17	32.7
	61&above	4	7.7
Sex	Male	22	42.3
	Female	30	57.67
Educational qualification	Secondary	4	7.7
	Tertiary	42	80.8
	Others	5	9.6
Marital status	Single	12	23.1
	Married	38	73.1
	Divorced	1	1.9
	Widow	1	1.9
Family size	1-2	7	13.5
	3-4	9	17.3
	5-6	32	61.5
	7-8	4	7.7
Major occupation	Civil servant	11	21.2
	Farming	24	46.2
	Trading	6	11.5
	Unemployed youth	8	15.4
Experience in farming (years)	1-10	33	63.5
	11-20	10	19.2
	Above 20	5	9.6
Membership of association	Yes	37	71.2
	No	15	28.8

Table 2: Ginger and turmeric production

1.	**Production experience (Year)**	**Ginger**		**Turmeric**	
		Frequency	Percentage	Frequency	Percentage
	1-5	12	23.1	10	19.2
	6-10	1	1.9	-	-
	No experience	39	75.0	42	80.8
2.	**Spice production before training**	9	17.3	9	17.3
3.	**Size of farm (Ha)**				
	<1	9	17.3	6	11.5
	1-2	1	1.9	3	5.8
3.	**Prospect in production**				
	High economic value	8	15.4	7	13.5
	Highly demanding	2	3.8	--	-
	Profitable	2	3.8	-	-
	No response	40	76.9	45	86.5
4.	**Purpose of planting**				
	Home consumption in fresh and dry form	6	11.6	4	7.7
	Sold in both raw and processed form	3	5.7	7	13.5
	Home consumption in fresh form	1	1.9	3	5.8

Table 3: Test of difference between pre and post knowledge scores of participants

Score	**Mean**	**SD**	**Df**	**T**	**p**
Post-knowledge Vs. Pre-knowledge score	16.63	8.24	51	14.56	0.00

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Assessment of Students' Knowledge about Pests in School Gardens of National Horticultural Research Institute's Adopted Schools in Oyo State

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Abstract
The study assessed students' knowledge of pests' infestation in school gardens in NIHORT adopted schools in Oyo state. Thirty percent of Junior Secondary School 3 students in two adopted schools were purposively sampled. Data were collected from 160 students using structured questionnaire and analyzed using descriptive statistics Horticultural(okra, jute mallow, mango, and pineapple) and arable (maize and cassava)crops are grown in the school gardens. Students (98.1%) are aware of pests and diseases infestation. Knowledge of the effects of pests and diseases shows that 43.1%, 31.3% and 16.3% of the students were able to deduce that it leads to reduction in produce quality, causes damages to crops and reduce crops growth respectively. Pests were observed in maize, cassava, okra and Corchorus by 53.8%, 48.1%, 21.9% and 5.6% of the students respectively. Insect pests mostly noticed were rodents (78.5%), grasshopper (72.4%), butterfly (52.8%) and snail (49.1%). Leaves were the most affected plant parts as observed by 89.4% of the students. Chemical treatment is mostly used for insect pest while controlled environment through fencing is mostly used for animal pests. Source of recommendation for treatment of pests' infestation on school gardens crops were mostly teachers (53.8%).Non-chemical control measures should be encouraged to control insect pests. There should be an enhancement of students' knowledge on harmful effects of pest and diseases in school gardens.
Key words: *Students knowledge, pests, crops grown, school garden*

INTRODUCTION

School gardens give students the opportunity of engaging in practical agriculture through hands-on experience (Hayden-Smith, 2010). School gardens allow students to become active participants in learning process, gain understanding of ecosystem, an appreciation for food origins and nutrition as well as knowledge of pests and diseases. It also supports inquiry, connection to the natural world and engages students in the process of formulating meaningful questions (Habib and Dohert, 2007).

Pests and diseases are an age long problems of agriculture. Pests constitute threat to crops andanimals at different stages of life (Adesina*et al*., 2014) or property. Fruits and vegetables are common in school gardens and these form part of a healthy diet because they provide vitamins and minerals (Eke *et al*., 2008). Biotic and abiotic factors are among the major constraints of fruit and vegetable production. Rain, heavy dews, warm temperatures, and dry climates have been reported as principal conditions that favor establishment of pests and diseases (Landston and Eaker, 2009). Youdeowei (2002) indicated that biotic constraints caused signi cant economic loss on vegetables in Ghana. In Cameroon, pests and diseases have been identi ed as major constraints to vegetable production (Ellis-Jones *et al*., 2008).Iwuchukwu and Uzoho (2009) indicated that the most important nancial constraints associated with vegetable production in Enugu State, Nigeria, were caused by the laborious nature of vegetable production and incidence of pests and diseases.Pests and diseases can cause both economic and health problems for farmers. Animal pest can feed on leafy vegetables and seeds thereby causing great damage on crops

Damage by insect pests mostly leaves openings or wounds on crops which could serve as points of entry for pathogenic

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organisms. Pest and disease incidence could also be a major challenge in school gardens especially if students cannot identify pestsand diseases infestation on crops. If no preventive and curative measures are in place, pest infestation could rise above threshold level which can cause economic damage and yield loss.In view of this, the study assessed knowledge of students about pests and diseases in school gardens in National Horticultural Research Institute (NIHORT) adopted schools. Specific objectives of the study are to:

i. Determine crops grown in school gardens in NIHORT adopted schools
ii. identify common pests and diseases in school gardens
iii. ascertainstudents' knowledge onthe effect of pests and diseases on crop plants
iv. determine crops affected/ plant part mostly affected based on students observation

METHODOLOGY

The study was carried out in Ibadan, Oyo state. The sampling involved a purposive selection of two adopted schools of NIHORT in Ibadan - Saint Teresa's College, Oke-Ado and Baptist Gramar School, Idi-ishin. Thirty percent of the Junior Secondary School 3 students in the two adopted schools were randomly sampled for the study. This gave a total of 160 students with 100 students and 60 students from Saint Teresa's College and Baptist Gramar School respectively. Structured questionnaire was used to elicit information from the students. The total number of students sampled from both schools was one hundred and sixty. Descriptive statistics such as frequencies and percentages were used to analyze the data collected.

RESULTS AND DISCUSSION

Crops grown in the school gardens

The results on Table 1 reveals that both fruits (plantain, mango, pawpaw, pineapple and cashew), leafy and fruit vegetables (amaranthus, jute mallow, okra and tomato) food and root crops (cassava, potato and maize) as well as groundnutform the arrays of crops grown in both schools.Specifically, maize, okra, jute mallow, groundnut, potato, plantain and tomatoes were grown in one of the adopted schools while fruits such as mango, pawpaw, pineapple and cashew and cassava form the bulk of crops grown in the second schools. In a school garden at Andhra Pradesh state, India,crops grown include tomatoes, carrots, chillies, amaranth, Indian spinarch, moringa, maize (Konmu, 2010). Vegetables commonly grown in the school gardens could be due to the fact that they are short duration crops that can be cultivated and harvested within twelve to fourteen weeks that make up a term. Availability of fruit trees in the school is a potential that could be a means of improving nutrition of students in the adopted schools.

Pests observed by students in school gardens

The most common pests in school gardens identified by the students were grasshopper (78.5%), rodent (72.4%), beetle (63.1%), butterfly (52.8%) and snail (49.1%). This is an indication that grasshoppers are more prevalent in school gardens in the study areas. The green nature of vegetable may be the reason for high incidence of grasshopper infestation in school gardens. Akinkunmi*et al*., 2017 reported that grasshoppers are polyphagous insect and can feed on any crop species.Rodent and grasshopper are commonpests of root crops and vegetables. Snail pest can be very destructive on leafy vegetable and some fruit crops.It can sometimes act as vector or carrier of disease pathogens. Human pest (30.79%) was also experienced in school gardens

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Awareness of the effect of pests and diseases infestation on crops

Most of the students (98.1%) are aware of the presence of pests and diseases in their school gardens.Most of the students were able to identify the observed insect pests but wereunable to identify diseases on the crops in their school gardens, this suggest the reason why no disease was mentioned by the respondents. Considering the effects ofpests' infestation on crops,43.1%of thestudents believed it could lead to reduction in produce quality, 31.3% opined it couldcause damage to crops while only 16.3% agreed it could bring about a reduction in crop growth (Table 2). The implication of this is that students are aware of pest and disease in school gardens but are not fully knowledgeable on the identification of disease symptoms on garden crops.

Crops and plant parts affected by pests in school gardens

Based on students' observation, 53.8% observed pest on maize planted in school gardens, 48.1% noticed pest attack on cassava. However, 21.9% and 5.6% of the students observed pest infestation on okra and*Corchorus* respectively. The major plant part attacked by pests as identified by 89.4 % of the respondents was the leaves (Table 4).

Personnel who recommended treatment

Chemical control method was the main participatory pest control measure used in both school gardens surveyed. The results showed that the recommended treatment forpests' infestation was done majorly bythe teachers (53.8%) (Table 5). This is a strong indication that teachers' knowledge should be upgraded from time to time with the current trend in pest and disease control using integrated pest management (IPM). This is to ensure production of safe food and maintenance of healthy environment. Use of chemical pesticides should be the last resort.To enhance food quality and safety, chemical pesticides and dosagesshould be strictly adhere to according to manufacturer's recommendations. All research institutes and necessary stakeholders should put appropriate feedback mechanism in place for effective monitoring of adopted schools.Monitoring and inspecting for rodent infestation provides the opportunity to identify rodent-conducive conditions before rodent begins infestation activities, rodent signs to watch out for includes droppings, gnaw damage, burrows, runways, tracks, grease or rub marks, urine stains, sightings of live or dead rodents, rodent sounds, and rodent odors (Environmental protection Agency, 2017). Trapsare used to control rodents and grasscutterbecause they live in the wild and attacked school gardens whilesnails are control in school garden by hand picking Fencing is used to control livestock pests such as sheep, goat and cattle. Hence, animal pest control can be achieved absolutely with fencing facility.

CONCLUSION AND RECOMMENDATION

Leafy vegetables,fruits,root crops and legumes form the arrays of crops grown in both schools. Most studentswere aware of the presence of pests and diseases in their school gardens. However, less than average number of thestudents believed pest and disease infestation could lead to reduction in produce quality, cause damage to crops and bring about reduction in crop growth.Grasshopper and rodents were identified as the most common pests in the school gardens surveyed.Damage by pests was mostly on the leaves of the crops. For school gardens to enhance sustainable environment, conscious effort should be made to train teachers and students on identification ofpests and diseases in school gardens and the need to adopt integrated pest management techniques to combat pestsin school gardens.

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Table 1: Crops grown in the school gardens

School	Common Crops grown
School 1	okra, jute mallow, groundnut, potato, plantain, tomato, mango, Cassava, Maize,
School 2	Okra, mango, pawpaw, pineapple, cashew, Yam, cassava

Source: Field Survey, 2018

Table 2: Awareness and knowledge of the effect of pest and disease among students

	Variable	Frequency	Percentage
Awareness	Awareness of pest of garden plants	157	98.1
	Awareness of disease in garden plants	157	98.1
	Observation of pest in school garden	157	98.1
	Observation of diseases in school garden	157	98.1
Knowledge	Reduction in produce quality	69	43.1
	It reduces crops growth	26	16.3
	It damages/destroys the crops	50	31.3

Source: Field Survey, 2018

Table 3: Frequency distribution of pests observed by students in the school gardens

Insect pest notice by students	Frequency	percentage
Grasshopper	128	78.5
Rodent	118	72.4
Beetle	19	11.7
Aphids	1	0.6
Butterfly	86	52.8
Whitefly	2	1.2
Human	50	30.7
Snail	80	49.1
grass cutter	52	35.6
Sheep	48	29.4
Larvae stage of some insects	43	26.4
Poultry	8	4.9
Goat	57	35.0
Cow	0	0

Source: Field Survey, 2018

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Table 4: Crops affected by pests in school gardens

Crops affected by pests	Frequency	Percentage
Maize	86	53.8
Okra	35	21.9
Cassava	77	48.1
Corchorus	9	5.6
Plant parts affected bypests		
Leaves	143	89.4
Fruits	7	4.4
Stem	4	2.5

Source: Field Survey, 2018

Table 5: Personnel who recommended treatment

Treatment recommendation	Frequency	Percentage
Teacher	86	53.8
Agrochemical dealer	1	0.6
Research institute	4	2.5

Source: Field Survey, 2018

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Socio-Economic Characteristics of Irrigated Tomato Farmers under Kano River Irrigation Project, Phase I, Kano State, Nigeria

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Abstract
The study examined the socio-economic characteristics of irrigated tomato farmers under Kano River Irrigation Project (KRIP) Phase I, Kano State, Nigeria. The study was based on primary data obtained in a cross section survey of 213 irrigated tomato farmers, using multi-stage sampling techniques in three local government areas covered by KRIP. The data were collected during the 2014/2015 irrigation farming season using well-structured questionnaire. Data collected were analyzed using descriptive statistics. The result indicates that majority (53%) of the irrigated tomato farmers were in their active years and approximately 57% had some form of formal education. Majority of the farmers (93%) had been in tomato production for 8 to 31 years and 71% of the farmers had less than 1.0 hectare of farmland. Majority of the farmers (78%) had no contact with extension workers while 76% used personal savings for production. Agricultural loan facilities by banks and Non-Governmental Organisations (NGO) should be made easily accessible to the farmers to ensure timely and adequate procurement and utilisation of agricultural inputs to improve farm production efficiency. Irrigated tomato farmers should join cooperative societies, so as to be able to benefit from the Governments and NGOs through increased credit access, input supply, training and other advisory services.
Keywords: *Irrigation, Tomato, Socio-economic characteristics, Kano-River*

INTRODUCTION

Agriculture in Nigeria is dominated by small-scale farmers who produce about 80% of the total food requirement (Fayinka, 2004). These farmers are characterised by strong dependence on agricultural labour market; little or no forms of savings or storage facilities and cultural practices adopted are highly labour intensive (Festus, 2005; Fakayode, 2008). The socio-economic and production characteristics of the farmers, inconsistent government policies leading to neglect of the sector, the poor infrastructural development, all interact and bedeviled the sector, resulting in low production and losses, inflation, underdevelopment and poverty. The problem of unemployment, poverty and malnutrition could be reduced with agricultural development. Adequate production of most Nigeria staple crops such as cereals, roots and tubers, other cash crops and some vegetables like tomato which is consumed all over, will contribute positively to the agricultural sector (Mohammed, 2011).

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetables grown for its edible fruits in virtually every part of Nigeria. It is an important source of vitamins, industrial commodity and an important cash crop for small-holder and medium scale commercial farmers (Shankara ,2005).

Nigeria imported a total of 105,000 metric tonnes of tomato paste valued at over 16 billion Naira, to bridge the deficit gap between supply and demand in the country (FAO, 2006). Kalu (2013) attributed this situation to socio-economic constraints surrounding the key actors in the tomato value chain, institutional weaknesses and declining agricultural research.

Nigeria is the fourth in Africa and leads in West African sub region, with an estimated output of 1.10 metric tonnes and average yield of 10 metric tonnes per hectare. United States of America is the

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leading importer of fresh tomato (25% of the world output). Due to lower yield and expansion in consumer population in Nigeria, demand for tomato paste continues to grow, resulting in expanded import in to the country.

Irrigation farming is relatively low in Nigeria and Africa as a whole with irrigated area estimated at only 6% of the total cultivated area compared with 37% for Asia and 14% for Latin America (FAOSTAT, 2009). Consequent upon which Byringiro, 1996 asserted that Africa is the only developing region where crop output and factor productivity growth are lagging seriously behind population growth.

In view of the above, it is important to invest on irrigation development with particular focus on locations and technologies with greatest potential for irrigation in Kano State. It is in recognition of the economic importance of Tomato production in the area and the state in general that this study intends to identify and describe the socio-economic characteristics of the irrigated tomato farmers.

METHODOLOGY

The Study Area

Figure 1: Map of Kano State showing the study area.

The Study was carried out in Kano State, Nigeria. Kano lies between latitude 12^0 37' North and 9^0 33' South and longitude 9^0 29' and 7^0 43' West. It shares boundary with Jigawa state to the North-East, Katsina state to the North-West and Kaduna State to the South. Kano State consists of two agro-ecological zones namely, Northern Guinea Savannah (NGS) and the Sudan Savannah (SS). The southern part of the state is in the NGS, which has an annual rainfall of 600-1,200mm. The central and Northern parts are in the SS, with an annual rainfall of 300-600mm (Kano State Government, 2012).

The state comprises of 44 local government areas with population of 9,383,682 (NPC, 2006).The projected population in 2017 with national growth rate of 3.0% is 13,345,497.90. The predominant ethnic groups in the study area are Hausa and Fulani.

The KRIP is one of the largest and successful projects, not only in Nigeria, but in West African sub-region. It is unique in its design in that the entire water distribution network operates on gravity.

The KRIP Phase I is currently providing all year round direct employment to about 41,250 farmers and their families. Farmers produce an average of 200,000 metric tonnes of food and cash crops valued at over 2.7 billion annually, thereby contributing significantly toward enhancing national food security (HJRBDA, 2013).

The major irrigated tomato producing local government areas in the state are Bunkure, Garun-Mallam and Kura, which are covered by the Kano River Irrigation Project (KRIP), Phase I, (HJRBDA, 2013). Large scale tomato production has been taken up along KRIP (Olanrewaju and Swarup, 1983). Two villages with the highest number of large scale irrigated tomato farmers from each of the three local government areas were purposively selected. Finally, random number sampling was employed to select **10%** of the total population **(**2,122**)** of the purposively selected villages, to prepare a sample size of 213.

Data Collection and Analytical Technique

The primary data collected and used was based on 2014/2015 irrigation farming season with the aid of structured

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questionnaire through the assistant of field enumerators in a manner that allows the collection of relevant data on specific variables that were investigated. Information was collected on the following variables of the respondents: age (number of years from birth), sex (dummy: male 1, female 2), educational level (non-formal, primary, secondary and tertiary), family size (number of people in a house and eating from the same pot), number of extension contacts (number of government extension visit within a production cycle), farming experience (measured in years), farm size (measured in hectares), sources of finance (formal or informal) and cooperative membership dummy: membership = 1, non-membership = 0).
Descriptive statistics was used to achieve the objective. Simple Descriptive statistics such as percentage frequency distribution, mean, standard deviation, minimum and maximum, were used to describe the socio-economic characteristic of the farmers.

RESULTS AND DISCUSSION

Age distribution

The results revealed that the mean age for respondents was 47. It implies that the farmers were within the active and productive working age of accepting new technology and innovations. This also agrees with the findings of Usman and Bakari (2013).

Educational level

The result shows that about 26%, 22% and 9% of the respondents had primary, secondary and tertiary education respectively while 43% of the respondents had non-formal educational qualification. Consequently, they could access information necessary to help them improve on their farming activities. Level of education of the irrigated tomato farmers' household is important in determining the household's ability to access, process and implement information on agricultural technologies (Zbinden and Lee, 2005).

Family Size

The average family size among the 213 respondents as shown in the socioeconomic characteristics in Table 2 was found to be approximately 10. This implies that the irrigated tomato farmer in the study area will have to be responsible for the feeding, clothing, sheltering, education of the able ones in the family, health care provision and other day-to-day expenses of their dependents. These expenses account for low savings at the end of the farming season and consequently the farmer had to compliment financing the next season through other sources of finance as only 22% of the respondents used personal savings to finance their production

Farming experience

The average years of experience of the respondents in cultivating irrigated tomato was found to be 19. This implies that the production is dominated by vast experienced adults who are in active years of their life. It is therefore, expected that farmers will achieve high level of productivity. The finding supports the findings of Maurice (2004) who reported a positive and significant relationship between farming experience and technical efficiency.

Extension service

The result in Table 3 revealed that majority (78%) of the respondents had no services of the extension workers at all during the cropping season and therefore the farmers are likely to be technically less efficient. Limited extension contact may reduce farmers' access to information on improved farm technologies. Mbanasor and Kalu (2008) in their study found that number of extension visits had a significant positive relationship with economic efficiency of commercial vegetable Farming in Akwa Ibom state, Nigeria.

Farm size

The result in Table 3 revealed that the mean farm size was 1.09 ha. Possession of small farm size could be due to mode of land acquisition in the study area which is

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predominantly through inheritance. This result agrees with Kalu (2013) who also found that tomato is produced on small holdings in Northern Nigeria.

Sources of finance

The result revealed that 22% of the respondents used their personal savings in the irrigated tomato production while 21% used their personal savings and family/friend's credit to finance production. This shows that most of the farmers cannot have access to some improved farm inputs and ability to expand their production. This agrees with the findings of Isah (2012) who also reported that lack of credit facilities affect production.

CONCLUSION

Since majority of the farmers financed their production through personal savings which are mostly not adequate for appreciable production, agricultural loan facilities by banks and non-governmental organisations should be made easily accessible to the farmers to ensure timely and adequate procurement and utilisation of agricultural inputs to improve farm production efficiency.

Irrigated tomato farmers should join cooperative societies, so as to be able to benefit from the government and non-governmental organisations, through increased credit access, input supply, training, and other advisory services.

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Table 1: Summary of Sampling Procedure (n=213)

Local Govt. Area	Village	Sampling frame S	M	L	Sample size (10%) S	M	L
Bunkure:	Gafan	342	68	32	34	7	3
	Dorayi	129	50	18	13	5	2
Garun Mallam:	Bangaza	62	27	35	6	3	4
	Agalawa	133	38	20	13	4	2
Kura:	Bugau	466	44	118	47	4	12
	Dakasoye	392	133	15	39	13	2
	Total:				**152**	**36**	**25**

Source: KRIP-WUCS (2014)

Note: 1.The villages were purposively selected based on high number of large size irrigated tomato farmers for the sampling.

2. S, M and L stand for Small, Medium, and Large sizes respectively

Table 2: Socio-economic characteristic on age, educational level and farming experience

Characteristics	Frequency	Percentage
Age		
20-29	7	3
30-39	29	14
40-49	83	39
50-59	62	29
60-69	32	15

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Mean	47	
Min.	20	
Max.	66	
Std. Dev.	10.14	
Educational Level		
Non Formal	91	43
Primary	56	26
Secondary	46	22
Tertiary	20	9
Family Size		
1-5	33	16
6-10	77	36
11-15	69	32
16-20	29	14
21 and Above	05	02
Mean	**9.7**	
Farming Experience		
0-7	10	5
13-15	78	37
16-23	52	24
724-31	68	32
32-39	5	2
Mean	19	
Min.	4	
Max.	35	
Std. Dev.	7.8	

Table 3: Socio-economic characteristics on extension service, farm size and source of finance

Characteristics	Frequency	Percentage
Extension Service		
Yes	47	22
No	166	78
Farm Size		
<1.0	152	71
1-2.9	36	17
3.0 and Above	25	12
Mean	1.09	
Min.	0.10	
Max.	10	
Std. Dev.	1.34	
Source of Finance		
Personal saving	213	22
Personal saving and family/friends	202	21
Money lender	195	20
Personal saving and bank	176	18
Personal saving and cooperative	186	19
Total	980*	100

* Multiple responses

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Determinants of Adoption of Improved Watermelon Production Practices in Kudan and Sabon- gari Local Government Areas of Kaduna State, Nigeria

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Abstract
This study was carried out to examine determinants of adoption of improved watermelon production practices in Kudan and Sabon- gari Local Government Areas of Kaduna State, Nigeria. Specific objectives of the study include description of the socio-economic characteristics of the watermelon farmers, evaluate adoption level and adoption index of the recommended production practices, and determinants of adoption of improved watermelon production practices. Using a multistage sampling technique which involved purposive and random sampling, one hundred and twenty farmers were selected from eight villages of Kudan and Sabon-gari Local Government Areas. Relevant data were collected for the study using structured interview schedules administered to the respondents. Results of the study showed that mean age of 41 years with 84.17 % of the respondents had small farm size of less than 2.1 hectares. Similarly, two-thirds (66.7%) of the farmers do not belong to any association while only 20% of the respondents had access to credit for watermelon farming. Plant spacing and weed control practices were the most adopted practices. The result of the logit regression estimates showed that extension agents, age and household size were significant at 1 % level of probability and significant determinants of the adoption of improved practices. Major recommendations based on the findings include formation of watermelon farmers' cooperative societies to facilitate positive interactions to enjoy advantages of group dynamics and improvement in the number and quality of extension agents that come in contact with the farmers.
Keywords: Determinants, Adoption, Watermelon Kaduna State

INTRODUCTION.

Watermelon (*Citrullus lanatus)* is one of the most widely cultivated crops in the world and the global production in 2017 reached over 100 million tonnes with China producing about 78% of the production (FAOSTAT, 2017). Watermelon belongs to the family of *curcurbitaceae* and grown for fruit and seed oil, maturing within 75-110 days (Mohammed, 2011). The main varieties grown in Nigeria include *sugar baby, kaolack, crimson sweet, black boy and sugar sweet.* Watermelon grows better in warm and sunny conditions and high rainfall encourages severe incidence of pest & diseases (Mohammed, 2011). Watermelon fruit is 91% water, contains 6% sugars, and is low in fat (Wikipedia, 2017). Many people relish watermelon across the world as a thirst-quenching fresh fruit that is known to be low in calories but highly nutritious. It contains vitamin A and C in form of disease fighting beta carotene. It also contain Potassium which is believed to help in control of blood pressure and possibly prevent stroke (Bosswell, 2000).

MATERIALS AND METHODOLOGY

Kaduna State occupies part of the Central position of Northern part of Nigeria and shares common borders with Zamfara, Katsina, Niger, Kano, Bauchi and Plateau States. The State occupies an area of approximately 48,473.2 square kilometers and is the fourth most populous state in Nigeria with a projected population of 11,236,043 in 2017 based on annual

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population growth index of 3.2% (NPC, 2006). There are two marked seasons in the State: the dry windy season and the rainy (wet) season. About 80% of the population are engaged in small-scale farming producing both food and cash crops. During the dry season, a considerable number of people in the state engage in irrigation farming along some major rivers and dams.

The respondents of this study are watermelon farmers who raised the crop either as a sole or mixed crop in eight villages from Kudan and Sabon-gari Local Government Areas of Kaduna State. Multi-stage sampling was used to select the respondents of this study. The first stage involved the purposive selection of two Local Government Areas known for watermelon production while the second stage involved a random selection of four villages from each of the two Local Government Areas where watermelon is grown that is Kudan and Sabon-gari. Finally, 20% of the population in each of the eight villages were selected for enumeration thus giving a sample size of one hundred and twenty respondents. These respondents were randomly selected from a sample frame of watermelon producers in the study areas.

Both primary and secondary data were used in the study. Primary data were collected from watermelon producers located in the study area through the use of questionnaires and structured interview schedules in the two selected Local Government Areas. The interview schedule was administered by trained extension agents in instances where the farmers could not read nor write in English. The primary data collected include socio-economic characteristics of the respondents such as age of respondents, the main sources of information which the farmers used and; the constraints the farmers face in using the information sources in the study area. The tools of analysis used for this study were descriptive statistics such as means, range, ranking, frequency counts and percentages. Logit regression models make it possible to estimate the probability of adopting an improved watermelon production practices.

RESULTS AND DISCUSSION

Socio-economic Characteristic of Respondents

The age distributions of watermelon producers revealed that majority (65%) of the watermelon farmers were within the active middle ages of 26 – 45 years with mean age of 41 years. About 99.15% of the farmers were males. Also, 85.0% of the respondents were married while 33.33% of the respondents had Quran and post primary education respectively. In terms of farm size, 84.17 % of the respondents had small farm size of less than 2.1 hectares and over 70.0% of the respondents had farming experience in cultivating watermelon for less than ten years. Similarly, 66.7% of the farmers do not belong to any cooperative organization while only 20% of the respondents have access for credit for watermelon farming (Table 1).

Adoption of improved production practices by watermelon farmers

Adoption level is described as the extent of adoption as described by Chikwendu (1999). He described adoption level as number of farmers accepting a particular technology without any consideration to the speed of adoption. This was measured for the purpose of this study as number of recommended practices adopted by the watermelon farmers acquired from the information sourcing. The adoption levels of the watermelon farmers in this study therefore, are 74% for improved seeds, 69% for fertilizer use, 66% adopted

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technology on use of chemicals and 79% adopted plant spacing technology. Also, 78% and 76% adopted weed control and harvesting practices, respectively. Storage practices were adopted by 58% of the farmers (Table 2).

Plant spacing (79%) and weed control (78%) practices had higher adoption rate. This indicates that they are central and critical factors in the cultivation of the crop (HortMag, 2004). Harvesting and improved seeds practices had 76% and 74% level of adoption, respectively probably because the farmers have a good chance of making more money through the high yielding varieties as reported by Budenhagen (1992). It could also be that these are material based practices which are simple and straight forward practices to transfer (Swanson, 1996). The relatively low adoption of storage technology (58%) may be because the harvested watermelon is mainly cured within the farm from where the crops are sold off ((HortMag, 2004). In general, all practices with high adoption level might be attributed to the fact that these practices fit in to the farmers' existing practices and most likely offered much attraction for farmers to adopt (Igbokwe, 2000).

Logit estimate of Information Sourcing and Adoption variables

The relationship between variables involved in adoption of improved watermelon production practices of the watermelon farmers was tested using the logit regression model. The result of the logit regression estimate in Table 3 showed that extension visit (X_1), age (X_3) and household size (X_7) were significant at 1% level of probability. On the other hand, education level (X_9), was also significant at 1% level of probability but it is inversely related, that is, it negatively influence adoption behavior of the watermelon farmers in the study area. Farm size was found to be significant at 5% level of probability and positively influenced adoption while membership of association is inversely related to adoption and significant at 5% level of probability. The chi-squared value was 73.81918 and was statistically significant at 1% (($p<0.01$) level of probability. This shows that the estimated model fits the data

Conclusion and Recommendation

The findings of the present study revealed that the watermelon farmers are mostly middle aged males with low education and cultivating small farmlands. The watermelon farmers are mostly non-members of associations and rarely have access to credit facility. The most adopted production practices are planting and weeding practices while extension agents, age and household size were significant at 1 % level of probability and significant determinants of the adoption of improved practices. The farmers should be encouraged to form cooperative organizations which will facilitate positive interactions especially on information dissemination, access to credit and also present a collective bargaining front to serve as a conduit for transmitting extension recommendations to and from the farmers.

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Table 1: Distribution of Watermelon Farmers According to Socio- economic Characteristics(n=120)

Variable	Frequency	Percentage	Mean
Age			
≤ 25	2	1.67	
26-35	41	34.17	
36-45	37	30.83	41
46-55	27	22.50	
≥ 56	13	10.83	
Gender			
Male	119	99.17	
Female	1	0.83	
Marital Status			
Married	102	85.00	
Single	17	14.17	
Divorced	1	0.83	
Household Size			
≤ 4	95	79.17	
5-8	22	18.33	12
9-12	3	2.50	
Educational Level			
No formal education	7	5.83	
Qur'anic education	40	33.33	
Adult education	6	5.00	
Primary education	12	10.00	
Post-primary education	40	33.33	
Tertiary education	15	12.50	
Land for Watermelon Production (ha)			
≤ 2.0	101	84.17	
2.1-4.0	15	84.17	
4.1-6.0	3	12.50	
≥ 6.0	1	2.50	
Years of Watermelon Farming			
1-9	84	70.00	
10-19	27	22.50	
20-29	9	7.50	
Membership of Association			
Yes	40	33.33	
No	80	66.67	

Access to Credit		
Yes	24	20
No	96	80
Produce Watermelon Every Year		
Yes	112	93.33
No	8	6.67

Table 2: Distribution of farmers according to adoption of recommended practices.

Recommended Practices	Frequency	Percentage	Ranking
Planting spacing	95	79.17	1
Weed control	94	78.33	2
Harvesting techniques	91	75.83	3
Improved seed varieties	89	74.17	4
Fertilizer application	83	69.17	5
Chemicals	79	65.83	6
Storage techniques	70	58.33	7

*Total frequency greater than **N** due to multiple response.

Table 3: Logit estimate of information sourcing and adoption variables

Variables	Coefficient	Standard error	t-value	p-value
Constant	1.699	1.364	1.246*	0.213
Extension visit (X_1)	1.375	0.469	2.931***	0.003
Gender (X_2)	0.211	0.329	0.641*	0.581
Age (X_3)	0.430	0.131	3.284***	0.000
Farm size (X_4)	0.677	0.288	2.351**	0.021
Marital status (X_4)	-0.681	0.495	-1.376*	0.169
Membership of association (X_5)	-0.925	0.370	-2.503**	0.012
Credit (X_6)	0.382	0.647	0.590*	0.555
Household size (X_7)	0.504	0.150	3.354***	0.001
Cost of adoption (X_8)	-0.283	0.199	-1.419*	0.156
Education level (X_9)	-0.706	0.199	-3.551***	0.000
Log likelihood function	-42.94552			
Restricted log likelihood	-79.85511			
Chi squared	73.81918***			
N	120			

Source: Field survey, 2014
Note: *** are significant levels at 1 %, ** are significant levels at 5 %; and* are significant levels at 10 %

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An Appraisal of Information Utilisation in National Horticultural Research Institute's (NIHORT) Library

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Abstract
This study was conducted to assess the level of utilization of information in NIHORT Ibadan library and variation of usage on yearly basis. Data were extracted from book loan register, visitors register, annual report register and production guide record from the year 2013 to 2017. Data obtained were subjected to descriptive statistics and correlation. The year 2014 had the highest patronage and an average readership of 60, 49 for books consulted, and 40 for journal consulted respectively while the year 2017 has the lowest patronage with a mean of 19 for readers, 43 for books consulted. The highest mean for journals consulted was recorded in 2017 with a value of 44.28. There was a strong correlation between readership and books consulted (0.83) for 2013; 0.89 (2014), 0.65 (2015), 0.69 (2016) and 0.94 (2017) with low patronage in the year 2016 and 2017 as compared to the year 2013 and 2014. The numbers of readership had a positive link with the level of consultation, this implies that the books available in the library affects the readership. Therefore it is important to equip the library with enough and updated information materials to make it conducive for higher patronage.
Key words: Information, Books, Journals, Patronage, Production guide.

INTRODUCTION

The outcome of any research can be affected by available information accessible to researcher. Libraries are established to collate document and provide information that can be utilized to achieve the aims and objectives of any research institutions. According to Aina *et al.* (1995), agricultural information comes in various forms such as textbooks, journals, conference proceedings, thesis, reprints, periodical occasional papers, production guides and annual reports among others. Utilization of these terms is a factor of the relevance and revision of relevant information materials.

Horticultural information is germane to attainment of food and nutritional security in Nigeria. Deshinkin (1980) stated that agricultural libraries and documentation personnel have a great role to play in providing timely and relevant information materials as agricultural information is key to national development in education, training and research. Before a library could be addressed as being effective, it must meet the information, research, recreation and educational needs of the users. Clearke, (1997) viewed that library effectiveness are concerned with determining how well the library meets the needs of users' in various discipline. Library effectiveness measures are concerned with determining how well the library meets the needs of users relative to the library goals and objectives Nwalo,(2001).

The dissemination of horticultural information is very crucial to agricultural productivity because it is only through these means that farmers can learn and adapt innovations which can improve their productivity (Namaseb, 1999). Salaam and Fatokun (2010) posited that the utility of a library's resources and services to its users could be determined by carrying out a survey on users' needs and the success in meeting them. Agricultural information

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users usually have specific information need based on their peculiarity. Ojiambo (1995) indicated that agricultural scientists are both information generators and consumers with their information needs varying, depending on their subject specialization.

The information materials acquired, organized and well preserved for dissemination to library users are articles published in various peer reviewed journals and conference proceedings. Selection of relevant horticultural information materials must be a joint effort by the selection committee constituted by the institution management which must consist of the researcher and the librarian. Supporting this view, Aguolu and Aguolu (2002) noted that librarians are expected to collaborate with the research staff in purchasing and stocking information materials.

Scientific and technical information become useful when its circulation is timely and reaches the people that need them (Fagbola and Adebisi-Adelani, 2007). Good literature search is very relevant to horticultural research planning and implementation, due to the important economic and nutritional roles horticulture plays. It is imperative for horticultural scientists to be equipped with current and adequate information for quality research planning and implementation, to enhance horticultural crops production in Nigeria (Fagbola and Adejoro, 2007).Therefore, an assessment of the level of utilization of different media of disseminating horticultural research information was carried out.

Objectives

1. To assess the level of utilization of information materials in NIHORT Library.
2. To identify the Information materials with the highest patronage across the years under study.
3. To find out the information and library needs of the users of the NIHORT Library.

Materials and Methods

Visitor register, Statistics record sheet containing records of all the library materials consulted, book loan register and production guide record of the National Horticultural Research Institute Library, Ibadan from 2013-2017 (5 years), was assessed. Monthly data were collected on number of readers, books/journals consulted, books borrowed, and annual reports / production guide read. All the data captured in the library tools above were sampled. Data obtained were subjected to analysis using descriptive statistics and correlation analysis.

Result and Discussions

The rate of utilization of information materials in the library is presented in Tables 1-5. Highest readership/ patronage of the library was experienced in the months of February to October. In 2013, the month of August recorded the highest number of users with the lowest recorded in the month of May. Production guide was not consulted as there was none available in the institute in year 2013, the readers, books consulted, books borrowed, journal consulted and annual report has a mean of 56.33, 55.17, 6.33, 28.67 and 9.83 respectively, also with a Standard Deviation(SD) of 41.29,42.98,9.5, 27.24 and 6.73 respectively. There was a higher consultation of books compared to Journals in 2013 and this reflected in the number of books (55.17) and number of journals consulted (28.67). According to CQUniversity Library (2018), Scholarly journals include information of academic interest, so they are not the best sources for

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general interest topics. Because the peer-review process can be time-consuming, they may not include up-to-the minute news or current event information.

Table 2 explains the use of information materials for the year 2014. The month of April had the highest readership, with a mean of 13.17%, Books (14.73%). The month of March had the highest The number of readers has a high correlation with the books consulted with a coefficient of .831** and it is significant at .001. Likewise with books consulted, books borrowed, Journals consulted and annual report.

Table 3 Show the use of information materials for the year 2015. The highest patronage was recorded in the month of March (18.13%), the highest number of books consulted was in the month of June (16.68%). Journals were highly consulted as well. The means were Readers (55.17), Books consulted (88.42), books borrowed (2.67), journals consulted (43.42), and annual report (6.33). There was no patronage in the month of January. The number of readers was highly correlated with the books consulted at 0.65, readers were also correlated with books borrowed, journals consulted and annual report, though that of annual report is not significant.

Table 4 describes the use of information materials in the library for the year 2016, the percentages, mean, standard deviations and the correlations between the readers, books consulted, books borrowed, journals consulted, production guide and annual report. Unlike other previous years, there was patronage in the month of January. The month of February had the highest patronage likewise the highest number of books consulted, with a correlation coefficient of 0.69. The highest patronage for Journals was also recorded for the month of February (38.86%). In the year percentage of books borrowed (23.25%) while the largest number of journals consulted was in the month of April (18.48%). The number of readers was positively and significantly correlated with the books borrowed at .888 and significant at .000.The month of January and December has the lowest patronage in the year, usually because of the festivities. 2016, production guide was made available and was mostly requested in the month of September (28.55%).

Table 5 describes the use of information materials in the library for the year 2017, it shows that the month of October has the highest number of readers (18.61%) likewise the books consulted (28.45%).

A similar trend was observed in 2014-2016, Production guide and Annual reports recorded lower utilization compared to Journals and books. Books borrowed and journals consulted recorded the highest coefficient of variation in the year 2013. There was strong correlation between readership and books consulted/borrowed. The correlation (r) varies between readership and books consulted were 0.83 (2013), 0.89 (2014), 0.65 (2015), 0.69 (2016) and 0.91 (2017). However, there was low correlation between readership and books borrowed as shown in r values of 0.42 (2014), 0.29(2015), 0.41(2016). Although 2013 recorded r value of 0.81 for 2013. The use of annual report was very low, factors that affect the effective use of academic libraries are due to unavailability syndrome and inadequate library resource facilities and services. Marteleto *et al* (1981).

Conclusion

It is observed that there is a decrease in utilization of the information materials in the institute library towards the years 2016 and 2017, as compared to the early years of 2013, 2014. This is as a result of

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electronic information resources available in the internet and databases.

There is a need for the researchers to liaise with extension agents in order to produce more production guides on different crops, so that the library users especially farmers will have access to current information on horticultural crop production. More annual reports should be updated, published and information resources to achieve a standard that suits the needs of the users. Library users and partnership with organizations and professional bodies.

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made available in the library. Acquisition of current books and journals in the library should be a priority to the Institute so as to improve the turnout of library users and this could be a joint effort between the Institute, according to Haliso and Aina (2012) that advocates for quality service in the area of collection of current, relevant and adequate print and electronic

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Table 1: Utilization Frequency of Information Materials for the Year 2013

Month	Readers	%	Book Consulted	%	Books Borrowed	%	Journals Consulted	%	Production Guide	Annual Report	%
January	10	1.47	1	0.15	-	-	-	-	-	8	6.77
February	86	12.72	41	6.19	8	10.52	53	15.40	-	3	2.54
March	70	10.35	38	5.74	9	11.84	40	11.62	-	7	5.93
April	90	13.31	88	13.29	4	5.26	-	-	-	12	10.16
	5	0.73	-	-	-	-	-	-	-	15	12.71
June	20	2.95	25	3.69	-	-	15	4.36	-	10	8.47
July	104	15.38	121	18.27	20	26.31	10	2.90	-	12	10.16
August	125	18.49	98	14.80	30	39.47	61	17.73	-	25	21.18
September	54	7.98	90	13.59	3	3.94	52	15.11	-	15	12.71
October	44	6.51	70	10.57		-	41	11.91	-	3	2.54
November	68	10.05	90	13.59	2	2.63	72	20.93	-	8	6.77
December		-	-	-	-	-	-	-	-	-	-
Total	676	-	662	-	76	-	344	-	-	118	-

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Table 2: Utilization Frequency of Information Materials for the year 2014

Month	Readers	%	Books Consulted	%	Books Borrowed	%	Journals Consulted	%	Production Guide	Annual Report	%
January	10	-	-	-	-	-	-	-	-	5	7.69
February	93	13.02	132	13.89	12	13.95	102	17.63	-	6	9.23
March	81	11.35	97	10.21	20	23.25	99	17.09	-	8	12.30
April	94	13.17	140	14.73	10	11.62	107	18.48	-	7	10.77
May	92	12.88	93	9.79			48	8.29	-	10	15.38
June	46	6.45	97	10.21	18	20.93	44	7.59	-	0	0
July	76	10.65	134	14.10	-	-	-	-	-	4	6.15
August	77	10.78	77	8.11	15	17.44	38	6.57	-	0	0
September	80	11.20	92	9.70	10	11.62	75	12.95	-	13	20
October	41	5.74	38	4.00	1	1.16	29	5.01	-	7	10.77
November	34	4.76	50	5.26	-	-	37	6.39	-	-	0
December	-	-	-	-	-	-	-	-	-	5	7.69
Total	714	-	950	-	86	-	579	-	-	65	

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Table 3: Utilization Frequency of Information Materials for the year 2015

Month	Readers	%	Books Consulted	%	Book Borrowed	%	Journals consulted	%	Production Guide	Annual Report	%
January	-	-	-	-	-	-	-	-	-	2	3.13
February	53	8.01	107	10.08	-	-	78	14.97	-	5	7.81
March	120	18.13	152	14.34	-	-	-	-	-	-	-
April	76	11.48	22	2.07	1	3.13	-	-	-	8	12.50
May	15	2.27	41	3.85	3	9.38	20	3.84	-	12	18.75
June	90	13.59	177	16.68	3	9.38	96	18.43	-	11	17.18
July	15	2.27	97	9.14	2	6.24	104	19.96	-	5	7.81
August	92	13.89	91	8.58	3	9.38	64	12.28	-	3	4.69
September	23	3.47	89	8.39	-	-	53	10.17	-	-	-
October	91	13.75	146	13.76	10	31.25	57	10.94	-	8	12.50
November	66	9.97	73	6.88	8	25.00	25	4.79	-	10	15.63
December	21	3.17	66	6.23	2	6.2	24	4.62	-	-	-
Total	662	-	1061	-	32	-	521	-	-	64	-

Table 4 Utilization Frequency of Information Materials for the year 2016

Month	Readers	%	Books Consulted	%	Books borrowed	%	Journals consulted	%	Production Guide	%	Annual Report	%
January	33	8.44	18	9.78	3	5.77	75	38.86	-		-	-
February	67	17.14	75	40.70	11	21.15	51	26.42	-		-	-
March	46	11.77	3	1.63	14	26.93	25	12.95			11	20.75
April	34	8.69	3	1.63	3	5.77	-	-	50	12.40	8	15.09
May	44	11.25	14	7.61	1	1.92	11	5.67	70	17.37	9	16.98
June	27	6.92	12	6.52	3	5.77	1	0.53	20	4.96	-	
July	39	9.97	15	8.15	3	5.77	1	0.53	6	1.49	15	28.30
August	35	8.95	8	4.35	-	-	17	8.80			-	
September	19	4.85	2	1.08	-	-	8	4.15	115	28.55	10	18.88
October	25	6.39	19	10.33	2	3.84	2	1.04	30	7.44	-	-
November	10	2.56	6	3.26	7	13.47	2	1.04	82	20.35	-	-
December	12	3.07	9	4.89	5	9.61	-		30	7.44	-	-

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Table 5 Utilization Frequency of Information Materials for the year 2017

Month	Readers	%	Books Consulted	%	Books borrowed	%	Journals consulted	%	Production Guide	%	Annual Report	%
January	31	9.30	8	1.75	3	7.89	3	0.72	21	7.07	-	
February	25	7.40	40	8.75	-	-	20	4.83	-	-	10	13.89
March	28	8.40	18	3.94	3	7.89	4	0.96	8	2.69	-	-
April	13	3.90	5	1.09	3	7.89	-	-	99	33.33	8	11.11
May	13	3.90	-	-	4	10.53	-	-	11	3.71	5	6.94
June	20	6.00	26	5.68	12	31.58	25	6.04	85	28.62	7	9.72
July	55	16.57	80	17.51	6	15.79	93	22.47	9	3.03	10	13.89
August	32	9.60	62	13.57	1	2.64	54	13.04	40	13.48	-	
September	44	13.21	88	19.26	2	5.26	115	27.79	16	5.38	8	11.11
October	62	18.61	130	28.45	4	10.53	100	24.15	8	2.69	15	20.84
November	10	3.00	-		-	-	-	-	-	-	9	12.50
December	-	-	-		-	-	-	-	-	-	-	-
Total	333		457		38		414		297	-	72	

Statistical Analysis

	2013			2014			2015			2016			2017		
Variables	Mean	S D	C V	Mean	S D	C V	Mean	S D	C V	Mean	S D	C V	Mean	S D	C V
Readers	56.33	41.29	73.30	60.33	33.01	54.72	55.17	39.41	71.43	32.60	15.81	48.50	27.75	18.60	67.03
Books Consulted	55.17	42.98	77.90	79.92	49.21	61.57	88.42	52.96	59.90	15.33	19.77	128.96	38.10	42.82	112.40
Books Borrowed	6.33	9.50	150.10	6.33	7.46	117.90	2.70	3.23	119.63	4.33	4.33	100	3.17	3.40	107.30
Journals Consulted	28.67	27.24	95.01	48.25	39.58	82.03	43.42	37.24	85.80	32.20	55.73	173.10	34.50	44.23	128.20
Production Guide	0	0	0	0	0	0	0	0	0	33.60	38.20	113.70	24.60	33.44	135.94
Annual Report	9.83	6.73	68.46	5.42	4.10	75.65	6.33	4.50	71.10	4.42	5.70	128.98	5.30	5.20	98.11

Financial Inclusion and Gender Disparity among selected Smallholder Horticultural Farmers in Nigeria

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Abstract
The financial inclusion of smallholder horticultural farmers in Nigeria is essential for horticultural transformation and value chain development. However,women smallholders suffer more financial exclusion than their men counterparts which limit their contributions to the sector.This study therefore investigated the statusof financial inclusion and gender disparity among selected smallholder horticultural farmers in Nigeria. Secondary data from the 2016 Nigeria Consultative Group to Assist the Poor (CGAP) smallholder household survey was utilized. Data were analyzed using Descriptive statistics and the Blinder-Oaxaca decomposition technique. Results revealed that 30% of smallholder horticultural farmerswere financially included; with higher inclusion (36% vs. 23%) found among the male smallholder horticultural farmers compared to the females. The Chi^2 test revealed that significant financial inclusion gender disparity exists at 1%. The highest absolute gap was found in account ownership in Bank Financial Institution(12.81%) and the least (1.55%) in account ownership in Non-Bank Financial Institutions (NBFI). Results of the Blinder-Oaxaca Decomposition revealed gender's endowments account for the major part of the mean gender gap (0.12)at 5% level of significance. However, the decomposed coefficientsand interaction of endowments and coefficients had more significant effects in reducing the financial inclusion gender disparity. Since the women smallholders find it easier to own accounts at NBFIs, this study recommends the need to facilitate the linkage of NBFIs such as Village Savings and Loan Associations (VSLAs) to Bank Financial Institutions for better financial inclusion impacts.
Keywords: *Financial Inclusion, Gender gap, Smallholder farmers, Horticulture, Nigeria*

INTRODUCTION

Nigeria made a commitment to the financial inclusion agenda in 2011 to reduce the percentage of those financially excluded from 46.3% in 2010 to 20% by 2020 (CBN, 2012). Financial inclusion (FI) is the access and usage of broad range quality financial services and products responsibly provided by formal financial institutions for all income groups and population (World Bank, 2017). Financial service or product is not synonymous to creditalone but include savings, insurance, payment, remittances and transfers.The access and usage of quality financial services are crucial because it unleashes the socioeconomic potential of the poor and enable them escape poverty traps (Yadav *et al.,* 2016). It reduces income inequality, facilitates consumption smoothening and investments in human and capital development (Aslan *et al.*, 2017).Increasing body of evidences in Nigeria (Evans, 2017) indicated that inclusive finance has a positive relationship on welfare, agricultural and economic growth.

Though the agricultural sector contributes significantly to Nigeria's economy, the horticultural sector's contribution to the former is indispensable. This is because of the obvious roles played by the sector in employment and income generation, economic diversification, food and nutrition security, poverty reduction and sustainable livelihoods (Mwende, 2016). While majority of the horticultural farmers in Nigeria are smallholders (Adebisi-Adelani, and Oyesola, 2013), women play significant roles in the horticultural value chain from production to consumption (World Bank, 2009). However, women

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have lower socioeconomic status despite their participation compared to their men counterparts due to unequal access and usage of productive resources and assets, markets, information, trainings, extension services and improved technologies that could enhance their productivity (Murithi, 2015;Tripathi et al. 2012).

While financial inclusion is a means to smallholder horticultural transformation and could enhance the socioeconomic status of the marginalized farmers, women's exclusion from participating in profitable investment opportunities may retard sustainable transformation (Fanta and Mutsonzinwa, 2016). Women smallholders are more likely than men to suffer financial exclusion whereas if given equitable opportunities, they could make maximum contributions to the sector like their men counterparts (IFC, 2016). Increasing population growth and demand for horticultural crops had called for modernization of smallholder horticultural crop production and better integration of gender roles and financial needs in the horticultural value chain. More importantly, the need to ensure women smallholders equally invest and benefit as entrepreneurs for inclusive economic growth. Therefore, the aim of this studyis to investigate the status of financial inclusion among selected smallholder horticultural farmers in Nigeria; assess whether there are gender disparities in financial inclusion and to identify the predictors of financial inclusion gender disparities.

MATERIALS AND METHODS

This study utilized secondary data from the 2016 Nigeria CGAP Smallholder Household Survey. The sample design was a stratified multistage sampling technique (Table 1). This involved the purposive selection of 215 Agricultural Enumeration Areas (AEAs) in Nigeria having smallholder households, followed by the selection of smallholder households proportionate to number AEAs in each geopolitical zone and the random selection of smallholders from states in each geopolitical zones based on proportion to size of AEAs.

However, for the purpose of this study, the smallholders were first stratified into horticulture and non-horticulture crop producers. This was followed by the purposive selection of producers of the horticultural crops identified under the mandate of the National Horticultural Research Institute (NIHORT). Three major questionnaires corresponding to three data sets for each household were used during the initial survey in order to avoid having a lengthy questionnaire and also obtain comprehensive data about the smallholders (Anderson, 2017). This study therefore utilized information on individual and household characteristics, horticultural activities, socioeconomics, access and usage of financial services and products which were distributed across the three data sets. To analyse the objectives of this study, the information for each respondent were merged across the three data sets into a single data file using their unique identifier. A total of 1260 smallholder horticultural crop producers comprising 724 males and 535 females were successfully matched using Stata 15 and utilized for this study. This imply the total number of respondents that have all their information contained across the three data sets. This study used descriptive analysis(frequency and percentage distribution, cross tabulation and chi – square test) and the Blinder-Oaxaca decomposition technique to analyze the objectives of this study.

Blinder Oaxaca Decomposition Model Specification

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The Blinder Oaxaca Decomposition is a counterfactual decomposition method used to evaluate the mean differences of an outcome variable between two groups using regression models (Jann, 2008). This study used the three fold decomposition to analyse the financial inclusion gender gap which is specified as follows:

$$Y_{iG} = \alpha_{0G} + \beta_{iG}X_{iG} + \varepsilon_{iG} \quad (1)$$

Where G indicates the gender group (m = male and f = female), Y_i is the outcome variable (Financial inclusion = 1; Financial exclusion = 0),X_i is a vector ofexplanatory variables,$\beta_i$is a vector of regression coefficients to be estimated and ε_i is the error term. Equation (1) can be rewritten as:

$$Y_i^m - Y_i^f = (\alpha_0^m - \alpha_0^f) + (\beta_1^m X_1^m - \beta_1^f X_1^f) + (\beta_n^m X_n^m - \beta_n^f X_n^f) + (\varepsilon_i^m - \varepsilon_i^f) \quad (2)$$

Such that

$$Y_i^m - Y_i^f = \Delta X_i \beta_i^{male} + \Delta\beta_i X_i^{female} + \Delta X_i \Delta\beta_i \quad (3)$$

Where:

$$\Delta X_i = X_i^m - X_i^f \ and \ \Delta\beta_i = \beta_i^m - \beta_i^f;$$

Therefore equation (3) can be rewritten as:

$$Y_i^m - Y_i^f = (X_i^m - X_i^f)\beta_i^{male} + (\beta_i^m - \beta_i^f)X_i^{female} + (X_i^m - X_i^f)(\beta_i^m - \beta_i^f) \quad (4)$$

The financial inclusion gender gap can therefore be attributed to gap in endowments (first component); gap in coefficients (second component) and gap in interaction between endowment and coefficient (third component) on the right hand side of equation (4) respectively.

Where:X_1= Age (years); X_2= Geographic location (urban = 1; 0 = rural); X_3 = Personal ownership of mobile phone (1 = yes; no); X_4 = Personal bank account ownership (1 = yes; 0 = no); X_5 = Mobile money awareness (1 = yes; 0 = no); X_6 = Access to information on the mobile phone (1 = yes; 0 = no);X_7= Contract farming (1 = yes; 0 = no); X_8 = Literacy (1 = yes; 0 = no); X_9= Land ownership with property right (1 = yes; 0 = no); X_{10}= Agribusiness attitude (1 = yes; 0 = no); X_{11} =Have a formal means of identification(1 = yes; 0 = no); X_{12}= Personal non-bank account ownership (1 = yes; 0 = no); X_{13}= Household income (naira); X_{14}=Household socioeconomic status (1 = above the poverty line; 0 = otherwise measured using the Progress out of Poverty Index (PPI));X_{15}= Household Decision making (1 = only male; 0 = female or joint)

RESULTS AND DISCUSSION

Status of Financial Inclusion And Gender Disparity

The results of the cross tabulation revealed that gender disparity exist across all the investigated indicators (Table 2).The highest absolute gender gap was found in account ownership in bank financial institution (12.81%) and the least (1.55%) in account ownership in non-bank financial institutions. Because formal account ownership is a prerequisite to the usage of formal financial services, the result implies women smallholders' horticultural farmers find it difficult to own and use bank financial services compared to non-bank financial services. This supported earlier findings (Fletschner and Kenney, 2011) that high transaction costs, social norms, institutional discrimination, women's time burden, lack of financial literacy and risky nature of agriculture makes women smallholders unattractive clients to formal financial service providers. Whereas, Women find it easier to use non-bank financial institutions such as village savings and loan associations (VSLAs) due to flexibility, proximity and less stringent

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conditions required to join groups or access financial services (CARE, 2013).While less than one-third (30%) of the smallholder horticultural farmers were financially included, higher inclusion (36% vs. 23%) was found among the male smallholder horticultural farmers compared to the females.Results of the Chi^2 test indicated the p-value (0.000) was statistically significant at 1% which imply a highly significant gender disparity exist in FI. A large FI gender disparity may facilitate other forms of gender inequalities in smallholder horticultural productivity and retard development.

Oaxaca Decomposition of Financial Inclusion Gender Disparity

Results (Table 3) revealed that the predictors in the estimated models significantly explained 91% of the variations in males' financial inclusion and 98% of the variations in females' financial inclusion at 1% ($p < 0.01$). The Blinder Oaxaca three-fold decomposition result revealed the mean FI for the male smallholder horticultural farmers was 0.24 and 0.15 for the females resulting in a mean financial inclusion gender gap of 0.09. The gap was further decomposed into three parts. Differences in endowments accounted for the major part of the gap (0.12) at 5% level of significance ($p < 0.05$), followed by gap in coefficients (0.05) at 10% level of significance ($p < 0.10$) and gap in interaction of the endowment and coefficients (-0.07) at 1% level of significance ($p < 0.001$). Results of the first component (endowments) implied the predictors significantly explained the mean financial inclusion gender gap and reflect the mean increase (0.12) if females have the same characteristics as their men counterparts. Likewise, result of the second component (coefficients) implied that the effects of the predictors significantly explain the mean financial inclusion gender disparity. It also indicates a mean increase (0.05) if the coefficients of the male characteristics were applied to the females. Conversely, result from the third component (interaction) implied that the simultaneous interaction of the differences in the predictors (endowments) and differences in the effects of the predictors (coefficients) significantly explain the mean financial inclusion gender gap with a mean decrease of 0.07.

Furthermore, results of the decomposed endowments revealed that, the gap in mean outcome would significantly (5%) increase by 0.06 if the females have non-bank accounts like their men counterparts. On the other hand, result of the decomposed coefficients revealed that the financial inclusion gender gap will significantly reduce if the effects of personal ownership of bank accounts (-0.01),decision making in horticultural households (-0.03) and ownership of non-bank accounts (-0.01) by the males were applied to the females respectively. In the same vein, the result of the decomposed third component revealed that the mean gender difference would significantly reduce if the interaction (-0.03) of the endowments and coefficient of household decision making and non-bank account ownership by males (- 0.01) were applied to the females at 5% and 10% respectively. In general, the results implied the effects of the predictors and the simultaneous interaction of predictors and their effects were more significant in reducing financial inclusion gender disparity than the gender's characteristics themselves.

CONCLUSION

This study found that only 30% were financially included with higher male inclusion across majority of all investigated indicators. The least gender gap was found in account ownership with

NBFIs such as Village Savings and Loan Associations (VSLAs). Gender's predictors (endowments) account for the major part of the mean gender gap in financial inclusion, the effects of the predictors (coefficients) and interaction were more significant in reducing financial inclusion gender disparity. This study therefore recommends the need to facilitate the linkages of smallholder horticultural farmers' associations and NBFIs to Bank Financial Institutions (BFIs)for greater sustainability and financial inclusion impacts.

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Table 1: Sampling technique

	Number/ Selection	Sampling technique
Agricultural Enumeration Areas purposively selected based on the National Integrated Survey of Households (NISH) Sample Frame	215	**Stratified Multistage Sampling**
Number of smallholder Households selected In each AEAs	17 smallholder households where possible were selected from each AEAs while retaining in the sample all smallholder households in AEAs with fewer than 17 smallholder households.	
Total number of households captured during initial survey	3026 smallholder agricultural households	**Stratified sampling technique**
Total number of households utilised for study	1260 (smallholder horticultural households)	

Table 2: Status Of Financial Inclusion And Gender Disparity

Selected Financial Inclusion Indicators	Total	Gender		Gender Gap	
		Male	Female	Absolute gap	Relative Gap
% account ownership in a bank financial institution	24.39 (307)	29.84 (216)	17.03 (91)	12.81	75.22
% account ownership in a non-bank financial institution	10.53 (133)	11.19 (81)	9.64 (52)	1.55	16.07
% Saved at a formal financial institution	18.73 (236)	22.31 (162)	13.89 (74)	8.42	60.62
% Borrowed from a formal financial institution	2.81 (35)	3.95 (28)	1.27 (7)	2.68	211.02
% Mobile phone ownership	81.06 (840)	83.12 (509)	78.09 (331)	5.03	6.44
% Mobile money awareness	3.15 (40)	4.43 (32)	1.42 (8)	3.01	211.97
% with ability to access information, markets and services on a mobile phone	20.10 (253)	19.12 (138)	21.43 (115)	-2.31	-10.78
% formal means of identification	89.16 (1123)	92.26 (668)	84.96 (455)	7.3	8.59
% Ever attended school	72.48 (913)	73.78 (534)	70.72 (379)	3.06	4.33
Overall Financial Inclusion	30.23 (381)	35.86 (260)	22.63 (121)	13.23	58.46
Test of Hypothesis	Pearson chi2(1) = 30.8405 Pr = 0.000				
$H_0 = 0$: No significant gender disparity in FI					
$H_1 \neq 0$: Significant gender disparity exist in FI	Likelihood-ratio chi2(1) = 31.5246 Pr = 0.000				

Source: Author (CGAP Smallholder Household survey, Nigeria, 2016)
*Figures in parentheses are standard deviations

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Table 3: Blinder Oaxaca Decomposition of Financial Inclusion Genderdisparity

Variables			Coefficient	Std. Err.	P>|Z|
Overall					
Mean FI: Males			0.241***	0.034	0.000
Mean FI: Females			0.149***	0.031	0.000
Mean FI Gender gap			0.092**	0.046	0.046
Gap due to Endowments			1.115**	0.050	0.020
Gap due Coefficients			0.046*	0.021	0.075
Gap due Interaction			-0.070***	0.025	0.006
Variables	**Model 1**	**Model 2**	**Oaxaca Decomposed Components**		
	Males (Coeff.)	**Females (Coeff.)**	**Endowments (Coeff.)**	**Coefficients (Coeff.)**	**Interaction (Coeff.)**
Age	0.016	0.008	0.002	-0.005	-0.001
Geographic location	0.001	0.003	0.003	-0.008	0.003
Personal mobile phone ownership	0.389	0.006	-0.003	-0.024	-0.018
Personal bank account ownership	-.0824	-0.954***	0.056	-0.014***	-0.008
Mobile money awareness	0.030	-0.087	-0.002	0.233	-0.004
Ability to access information on the mobile phone	0.018	0.019	-0.001	-0.002	-0.005
Contract crop sales	-0.032	-0.033**	0.005	0.002	-0.001
Literacy	0.029	0.027*	$1.56e^{-06}$	0.017	$1.17e^{-07}$
Land ownership with property right	0.008	-0.009	-0.002	0.007	0.004
Agribusiness Attitude	0.064	-0.018	-0.002	0.075	0.007
Formal Identification	-0.088	-0.008	-0.020	-0.058	-0.020
Personal non-bank account ownership	0.690***	0.916***	0.056**	-0.010**	-0.014*
Household Income	$-3.71e^{-08}$	$-3.02e^{-08}$	-0.002	-0.002	-0.005
Household socioeconomic status	0.044	0.018	-0.005	0.007	-0.007
Household decision making	-0.062**	0.019	0.007	-0.030**	-0.030**
Constant	1.587***	2.056***			
R-squared	0.908	0.980			
Adjusted R-squared	0.898	0.977			
Prob > F	0.000	0.000			

Source: Authors (CGAP Smallholder Household survey, Nigeria, 2016)

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Role of Biodiversity Conservation in Environmental Sustainability

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Abstract
This paper assesses the role of Biodiversity Conservation in environmental sustainability. It also examines the importance of Biodiversity to green economy. The paper highlights several ways of conserving biological diversity and its role in environmental sustainability such as creation of parks and gardens, avoidance of illegal felling of trees. Also highlighted, are some traditional practices, which will promote environmental sustainability such as agroforestry practices as well as urban/avenue tree planting and school programs, establishment of woodlots. The paper also explained the role of biodiversity as a component of green economy to the environment such as prevention of erosion, genetic loss; promote economic and cultural use of natural resources as well as understanding of environmental issues, especially climate change.
Keywords*: biodiversity conservation, illegal felling, environmental sustainability*

INTRODUCTION

Tropical rainforest over the years has been known to be richest in biodiversity. The destruction of rainforest abundant bio-resources is due to human-use pressure as a result of increase in population, has drastically reduced the abundance of biodiversity and its functions. Biodiversity according to Agabi (1995) refers to the living world, the variety of life- forms found on the planet, earth and the millions of plants and animals. Biodiversity according to Saba and Dore (1991), the combination of renewable natural resources and the ecological services, which arise from normal functioning of the ecosystem, may be considered as the biological resources endowment. The endowment is based on genes, species and ecosystems, which have actual or potential value to the people. Biological resources are manifested as biological diversity. This term refers to the variety in numbers and prevalence of ecosystems, species and genes, thus implying genetic diversity, species diversity and ecosystem diversity (Joshua and Umoren, 2009).

Biodiversity also refers to the number, variety and variability of all living organisms in terrestrial, marine and other aquatic ecosystems and to the ecological complexes of which they are part. On the other hand, biodiversity conservation involves a wide spectrum of activities and behaviors including protection of plant and animals species from reckless exploitation, sustaining food production without damage to the maintaining or even raising the level of cleanliness and the aesthetic of the environment (Agabi 1995). Conservation is concerned with the protection, preservation and wise use of resources. It means the management of a particular resource for maximum continuing product consistent with the maintenance of a constantly renewable stock (Okebukolon and Akpan, 1999).

The forest and waters constitute veritable natural assets providing the right habitat for a myriad of living thing that are useful in agricultural and medical sciences. For human survival and well-being, these assets must be conserved by promoting their protection from loss, waste and damage through sustained yield

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management and care (Magome, 2000). Ecologists and non-ecologists alike are committed to conservation of these forests and waters, which contains resources, some of which are non-renewal (e.g Coal, oil, metallic ores, etc) while others are renewable resources (e.g Wood, grassland, fish and wildlife).

Biodiversity Conservation

Conservation is a relatively new science devoted to the conservation of biological diversity. Conservation biology is, of necessity, multidisciplinary in recognition of the need to involve many professional field of success at so daunting a task is to be assured (Emeh, 1996). Those involve ecology, biology, genetics, anthropology, philosophy and economics among others (Primark, 1993). Conservation biology works in ex-situ and in-situ contexts. In other words, conservation of biodiversity can in part take place through gene banks and captive breeding of species in zoos, but the goal is best served through protection of natural areas, their component species and the ecological and evolutionary processes occurring there (Okebukola and Akpan, 1999) This concept also means preservations or preventions from loss of the living organisms most of these changes have adverse effects on life forms, hence, the need for conservation. Conservation must maintain the capacity of ecosystems and the human communities that depend directly or indirectly on the resources.

The concept of green economy involve a systematic and a holistic towards enriching our environment with plant life forms of high economic values, ranging trees, shrubs, herbs climbers and grasses. There are several approaches through which biodiversity conservation can be achieved. Some of which are: afforestation by tree and grass planting: the practice of shifting cultivation and crop rotation: the use of natural manure's to increase soil fertility and preservation soil texture from the effects of erosion by water and wind creation of national parks and forest reserves to conserve one forest and plant and animals species; avoiding bush burning; maintain hunting and fishing laws which prohibits the killing of young animals for food; making and observing conservation laws; consciously involving in environmentally- friendly activities; positive attitudes toward preserving the environment.

The success of the above approaches is embedded upon the environmental education and a kind of getting- bank- to-basics. In other words, encouraging traditional methods of agriculture, agroforestry, range and wildlife management, maintaining or increases biodiversity, involve communities including women in conservation and managing ecosystems.

Environmental Education

The successful conservation of biodiversity may be achieved through environmental education. People must be made to understand what it is important and whose interest to conserve. These are several ways of creating awareness in the people about environmental conservation. Mass media and environmental projects in which radio and TV are made to sound warnings on the consequences of environmental degradation especially before and after events in local and national news. Print media such as posters should be displayed to show some aspects of the general abuse on the environment as well as newspapers, magazines, and booklets.

Some Traditional and Conventional Conservation Practices that Enhances Green Economy

Agroforestry practice

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This is a form of multiple land-use system whereby agricultural crops and forestry trees are planted on the same piece of land. In agroforestry, trees and other shrubs that can protect the environment against agents of environmental degradation such as erosion and erosion and flooding are planted. The tree can also serve as a source of wood, energy, food, fibre, medicine, pole, furniture as well as pulp and paper, apart from environmental protection, agroforestry will also enhance the raising of animals through agrosilviheliculture, as well as mycosilviculture (agrosilvimycology). This system will also to a larger extent encourage the homestread garden management where most of the forest vegetables are grow for man's consumption as well as live fences for boundary demarcation (Etukudo 2000). The planting of some selected fast grown species of leguminous tree in agroforestry also enhance the fixation of nitrogen in the soil through modulation by nitrogen-fixing bacteria.

This in turn helps to increase soil fertility for high yield. The flow of energy or matter through the original system is therefore little disturbed and net productivity rates are maintained at an almost constant level. Erosion is checked because the ground is well covered during the wet season when run- off intensity is high.

Urban Tree Planting

This practice is another way to enhanced green economy concept and conservation of biological diversity. It involves the planting of different species of tree of diverse importance in urban area of a particular state. Before the planting commences, the objectives of the tree species must be identified such as planting for aesthetic/ornamental values, landscaping of the environment, provision of shades or for erosion control. The beautification of the town depends on the selection of the trees of high aesthetic values. The trees may be combined with shrubs that produce beautiful flowers as well as climbers. Urban greening is very important in protecting the environment. In urban centers, it is observed that space for planting of trees is a challenge. In this regard planting of avenue trees may be strongly recommended and must be handled by expert applying high sense of landscaping technology. The practice of this will enhance the concept of green economy to a larger extent.

Schools Programmes

This programmme should be carried out by the youth of the country. The rational being that any far-reaching, permanent and meaningful progress can only be made if the youth are properly informed about sustainable resources and human survival, especially this era of climate change. The effectiveness of the strategy lies on the fact that children are more receptive to new experience than adults and these would grow with them as they mature. The school approach to environmental education is as high priority. This will enable the children to cultivate environmental protection habit early in their lives. The children may at the same time help to remind their parents of this concept because they always report what they hear and see to their parents.

Botanical Gardening

Botanical gardening is another important way in which biological diversity can be conserved. This involves the planting of different species of plant life forms in a demarcated piece of land. The species are mostly the ones that are endangered or facing the danger of extinction. The establishment of botanical garden serves a multipurpose function especially in medical field, where some extracts are generated from some certified medicinal

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plants for treatment of diseases in human being, animals and plants. It also serves as a bank for genetic diversity, ranging from trees, shrubs, herbs, climbers, grasses and even micro- flora.

The Role Of Green Economy in Environmental Sustainability

The issue of green economy stems from the importance of biodiversity conservation. In simple term, biodiversity expresses the extent of the living natural resource of an area. Its characteristics are expressed in term of the perspective of concern but essentially as genetic, species and ecosystem variability. It is often emphasized that those are ethnical, ecological and economic reasons for wanting to preserve genetic diversity through green economy. The species that are lost cannot be replaced and are gone forever. Losing them could interfere with essential ecological processes since has a function within its ecosystem.

Therefore, the following are some of ecological importance of green economy through biodiversity conservation: Maintenance of water cycles through precipitation ; regulation of climates at both the macro and micro-climatic levels; control erosion of both soil and coastline; maintenance of essential nutrient and other natural cycle (including Oxygen, carbon, nitrogen and sulphur as well as maintenance of oxygen/carbon dioxide balance in the atmosphere); photosynthetic fixation of energy, whereby energy from the sun is transferred through green plant to the ecosystem as a whole; sequestration of carbon dioxide from the atmosphere.

The threat factor to biodiversity in Nigeria is similar to those in other countries in sub Saharan Africa. These include population pressures, food production methods. Foreign debt servicing, commercial lands use practices, over-harvesting, non-viable populations of species, climate change and the introduction of alien species. In this regard, biodiversity conversation can be considered as an umbrella term for traditional species and ecosystem in a sustainable manner. The depletion of biodiversity leads to scarcity of valuable bio-resource and denies human of the opportunity for obtaining new species to new challenges in medicine, society and agriculture (FEPA. 1999).

In line with global concern expressed at the United Nations Conference on Environment and Development (UNCED) of 1992 and the Convention on Biodiversity, the Nigeria's National Agenda 21 of 1999 proffer the basis for biodiversity conservation as follows: To prevent genetic loss, to preserve and enhance the potential for the future use of flora and fauna: to promote economic and cultural use of biodiversity in a sustainable manner; to promote sustainable use of biodiversity for medical purpose; to establish a data-base on natural bio-resources; to promote eco-tourism; to develop and adopt comprehensive biodiversity and conservation strategy; to train personnel as the essential catalyst for better understanding of environmental issue and commitment to sustainable use of resources (Okebukola and Akpan, 1999; Etuk etal., 2009).

CONCLUSION

Biodiversity conservation has been identified to be component of green economy and its roles in environmental sustainability cannot be over emphasized. Biodiversity conservation embraces the conservation of all life forms, which are biologically originated ranging from plants and animals. In conserving the biological diversity, it ensure a diverse ecosystem services such as carbon sequestration by green plants, provide habitats for wild animals, ensure balance in an ecosystem, ensure energy flow and balance in

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ecosystem through different path ways, and improvement in soil fertility through decayed organic matter thereby ensuring food security. Therefore, green economy should be harnessed and practiced in sustainable manner to foster immense benefits to the environment. This can be achieved through environmental education by inculcating such innovation into their minds and showing practical demonstration of biodiversity conservation so as to catch the interest of the people toward green economy and environmental sustainability.

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Growth and Yield of Cucumber (*Cucumis sativus* L) as Influenced by Staking and Plant Spacing in Lafia, Nasarawa State, Nigeria.

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Abstract
Field experiment was conducted for two years during the rainy seasons of 2016 and 2017 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu –Lafia Campus (8^0 34' N and 80 33'E) to evaluate the effects of Staking and varying planting spacing (30 x 30cm, 30 x 40cm, 40 x 50cm and 50 x 50cm) on the growth and yield of cucumber. The eight treatment combinations were laid out in Randomized Complete Block Design (RCBD) with four replications. The results obtained showed that vine length, number of branches, numbers of leaves and fruits per plant, fruit diameter, fruit length and fruit yield per hectare of cucumber were significantly increased by staking and planting at a spacing of 40 x 50cm compared to non staked plots and other planting spacing (30 x 30cm, 30 x 40cm and 50 x 50cm). For improve quality and higher yield of cucumber, farmers should adopt staking and a planting spacing of 40 x 50cm in this agro-ecology.
Keywords: *taking, Plant Spacing, Sustainable Yield, Cucumber, Agro Ecology*

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is an important vegetable crop in the *Cucurbitaceae* family. Cucumbers were consumed in Western Asia, Greece and ancient Egypt as long as 3000 years (Elmhirst, 2006). According to Alpaslan and Gunes (2001), it is an important vegetable crop for human nutrition in the world. It is a creeping vine that bears cylindrical fruits that are used as culinary vegetables. Ayotamuno *et al.* (2000) reported that Cucumber is a major fruit vegetable that is eaten raw (in salads) or cooked. It is a crop of medicinal values such as: rehydrating the body; replenishing of daily vitamins; stimulating of hair growth; curing of skin irritation; aiding digestion and weight loss; etc (Haruna and Nantip, 2015).

Adequate plant spacing will reduce competition for light, will conserve water, and will provide more soil nutrition to each plant. Un-staked cucumber plants can get infected by soil borne diseases easily. They also take space and make it difficult to work on the farm (Haruna, 2011).

Staked cucumbers make it easy to increase plant population density and in most cases, perform better with greater yields. Staking of cucumber has been found to help optimize yields, and make harvesting easy. Higher fruit yield was observed on staked treatment than for the non-staked treatment (Hardy and Rowell, (2002); Hirata and Tilato (2000). Also, Nelson (2005) and Paulo *et al*; (2003) reported increases in fruit yield with increase in plant density.

Work on the effects of planting spacing and staking on the growth and yield of cucumber has not been carried out in this agro-ecology. Despite the importance of cucumber highlighted above, its production is still mainly in the hands of peasant farmers in Nigeria who lack information on good production practices such as staking and right spacing for optimum yield of the crop. This work therefore seeks to evaluate the productivity of cucumber as influenced by staking and planting spacing.

MATERIALS AND METHODS

Field experiment was conducted for two years during the dry seasons of 2016 and 2017 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi, Shabu –Lafia Campus (8^0 34′ N and 80 33′E) to determine the effects of Staking and varying planting spacing (30 x 30cm, 30 x 40cm, 40 x 50cm and 50 x 50cm) on the growth and yield of cucumber. The eight treatment combinations were laid out in Randomized Complete Block Design (RCBD) with four replications.

The gross plot size was $16m^2$ (4m x 4m) while the net plot size was $9m^2$ (3mx 3m). The experimental area was harrowed followed by construction of seed beds. Between each plot was an unplanted border of 1m while between each replication, there was an unplanted border of 2m. Poultry manure (5 tons ha^{-1}) was incorporated into all the seed beds and left for 2 weeks before planting to reduce the scotching effect of the poultry manure on the seeds. Sowing was done on seed bed at 30cmx50cm, 40cmx50cm and 50cmx50cm planting spacing according to field plan and treatment combinations.

Growth parameters such as vine length, number of branches per plant, number of leaves per plant were assessed at 4, 6, 8 and 10 weeks after sowing on 5 randomly selected tagged plants in each plot. Cucumber vine length was measured by using a flexible measuring tape. Number of leaves was assessed by visual count of the functional leaves on the randomly selected tagged plants and the mean recorded. Number of branches was taken by visual count of the branches on the randomly selected tagged plants and the mean recorded. At every harvest, fruit diameter was assessed by using a Vernier caliper, the fruit length was measured by using a flexible tape before the fruits were weighed using a Salter scale. Number of fruit per plant was assessed by counting the number of fruits from the randomly selected tagged plants and the mean recorded. The cumulative weights of the entire harvests (10 times) from each plot were summed up and the value obtained was converted to per hectare basis. The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1990) and significant differences among the treatment means were evaluated using Duncan's Multiple Range Test as described by Duncan (1955).

RESULTS AND DISCUSSION

Vine length (cm)

Table 1 shows the effects of spacing and staking on the vine length of cucumber at 4, 6, 8 and 10 weeks after sowing (WAS). The results obtained showed that a spacing of 40 x 50cm produced significantly taller plants compared to all other spacing used at all sampling periods. Increasing the planting spacing from 40 x 50cm to 50 x 50cm produced shorter vine lengths at 4,6 and 8 WAS but at 10 WAS, the vine length at 40 x 50cm was statistically at par with that of 50 x 50cm. Staking of cucumber produced significantly, plants with longer vine lengths compared to plots that were not staked at all sampling periods

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Number of Leaves per Plant

Effects of spacing and staking on the number of leaves of cucumber at 4, 6, 8 and 10weeks after sowing (WAS) is presented on Table 2. The results obtained showed that a spacing of 40 x 50cm roduced significantly higher number of leaves compared to all other spacings used at all sampling periods. Planting at a spacing of 30 x 30cm and 50 x 50cm at 4 and 6 weeks after sowing (WAS) produced plants with statistically similar number of leaves.

Staking of cucumber produced plants with significantly higher number of leaves compared to plots that were not staked at all sampling periods. Interactions between the factors tested were not significant at 4, 6, and 8WAS but at 10WAS, highly significant interaction occurred between spacing and staking at 10WAS.

Number of Branches per Plant

Planting at a spacing of 40 x 50cm and staking of cucumber produced significantly plants with higher number of branches compared to all other spacing used at all sampling period and plots that were not staked (Table 3). At 10WAS, significant interaction occurred between spacing and staking on number of branches per plant.

The results of the interaction showed that if staking is held constant, the number of branches significantly increased with varying planting spacing up to 40 x 50cm and then decreased at 50 x 50cm plant spacing. The highest number of branches was gotten by planting at a spacing of 40 x 50cm and staking (Table 4).

Fruit Diameter, Fruit Length, Number of Fruits per Plant and Fruit Yield (t/ha)

Table 5 shows the effects of staking and varying plant spacing (30 x 30cm, 30 x 40cm, 40 x 50cm and 50 x 50cm) on fruit diameter, fruit length, number of fruits per plant and fruit yield (t/ha) of cucumber. The results obtained showed that a planting spacing of 40 x 50cm and staking produced significantly higher fruit diameter, fruit length, number of fruits per plant and fruit yield of cucumber per hectare compared to in which the cucumber were planted at 30 x 30cm, 30 x 40cm and plots that were not staked. Planting spacing of 40 x 50cm and 50 x 50cm produced statistically similar fruit diameter and fruit length but higher than those planted at 30 x 30cm and 30 x 40cm. Significant interactions occurred between spacing and staking on the number of fruits per plant, fruit yield per plant and fruit yield per hectare.

The results of the interaction between spacing and staking on the number of fruits per plant, fruit yield per plant and fruit yield per t ha^{-1} showed that if spacing is held constant, the number of fruits per plant, fruit yield per plant and fruit yield per t ha^{-1} significantly increased with staking. The highest number of fruits per plant, fruit yield per plant and fruit yield per t ha^{-1} were gotten by planting at a spacing of 40 x 50cm and staking (Tables 6).

DISCUSSION

From the results presented above, it can be seen that all the growth, yield and yield characters measured were significantly enhanced by planting cucumber at 40 x 50cm spacing. This could be attributed to the fact that at this very spacing optimum plant population was reached thereby increasing water and nutrient use efficiency, effective utilization of sunlight energy for photosynthetic activities that translated to significant growth and yield of the plant.

Similarly, staked cucumber produced significantly higher growth, yield and yield characters measured compared to those that were not staked. This could be attributed to

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the fact that staking of cucumber has been found to help optimize yields, by exposing the leaves for maximum sunlight absorption for efficient photosynthetic activities that translated to higher growth, yield and yield characters compared to plots that were not staked. Fruits quality were also found to be better in staked plots compared to un-staked plots and harvesting was made easy.

This finding is in conformity with those of Nelson (2005) and Paulo *et al*; (2003) who all reported increase in fruit yield with increase in plant density. Jansen (1985) concluded that staked cucumber produced fruits double the quantity of the ones on the ground.

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Table 1: Effects of spacing and staking on the vine length of cucumber at 4, 6, 8 and 10weeks after sowing (WAS). Data pooled 2016 - 2017

Treatment	**4WAS**	**6WAS**	**8WAS**	**10WAS**
Spacing (cm)				
30 x 30	9.0d	56.5d	86.9c	103.5c
30 x 40	12.4b	64.3b	95.1b	123.7b
40 x 50	16.9a	68.7a	102.5a	129.4a
50 x 50	11.4c	58.2c	95.4b	128.5a
SE±	0.27	0.58	0.66	2.64
Staking				
T1	9.5b	53.3b	85.8b	109.0b
T2	15.3a	70.6a	104.1a	133.5a
SE±	0.19	0.41	0.47	1.87
Interaction				
Spacing x staking	NS	NS	NS	NS

Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability. T1 = control (un-staked plants) T2 = staked plants NS= not significant

Table 2: Effects of spacing and staking on the number of leaves of cucumber at 4, 6, 8 and 10week after sowing (WAS). Data pooled 2016 - 2017

Treatment	4WAS	6WAS	8WAS	10WAS
Spacing (cm)				
30 x 30	8.3c	24.7c	46.2c	65.6b
30 x 40	9.4b	28.3b	49.8b	59.3d
40 x 50	12.6a	30.9a	55.4a	74.1a
50 x 50	8.3c	23.8c	40.6d	61.4c
SE±	0.39	1.33	0.40	0.44
Staking				
T1	8.2b	22.2b	40.0b	54.5b
T2	11.0a	31.7a	55.9a	75.7a
SE±	0.28	0.94	0.28	0.31
Interaction				
Spacing x staking	NS	NS	NS	NS

Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability. T1 = control (un-staked plants) T2 = staked plants NS= not significant

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Table 3: Effects of spacing and staking on the number of branches of cucumber at 4, 6, 8 and 10weeks after sowing (WAS). Data pooled 2016 - 2017

Treatment	4WAS	6WAS	8WAS	10WAS
Spacing (cm)				
30 x 30	2.7c	13.5d	28.2d	44.9c
30 x 40	3.8b	15.1c	31.1b	45.7b
40 x 50	5.2a	17.9a	39.7a	47.8a
50 x 50	2.9c	16.9b	30.1c	44.4d
SE±	0.24	0.62	0.35	0.46
Staking				
T1	2.4b	12.9b	26.2b	40.7b
T2	4.9a	18.7a	38.3a	50.7a
SE±	0.17	0.44	0.25	0.32
Interaction				
Spacing x staking	NS	NS	NS	**

Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability T1 = control (un-staked plants) T2 = staked plants NS= not significant
*** = significant at 1% level of probability..*

Table 4: Interaction between spacing and staking on the number of branches of cucumber at 10WAS. Data pooled 2016 - 2017

SPACING (cm)	STAKING	
	T1	T2
30x30	39.8g	50.1c
30 x 40	42.3f	49.0d
40x50	43.2e	52.4a
50x50	37.4h	51.3b
SE±	0.123	

Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability. T1 = control (unstaked plants) T2 = staked plants LSD = Least Significant Difference

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Table 5: Effects of treatments on fruit diameter, fruit length, number of fruits per plant and fruit
yield (t/ha). Data pooled 2016 - 2017

Treatment	Fruit diameter (cm)	Fruit length (cm)	Number of fruits per plant	Fruit yield per plant (kg)	Fruit yield (t/ha)
Spacing (cm)					
30 x 30	17.6c	18.0c	10.8c	2.3d	70.9c
30 x 40	18.4b	18.8b	10.7c	2.9c	83.7b
40 x 50	19.3a	19.9a	12.8a	3.8a	100.1a
50 x 50	19.2a	19.2a	11.9b	3.6b	84.3b
LSD SE±	0.34	0.33	0.26	0.13	2.62
Staking					
T1	17.2b	17.6b	10.1b	2.1b	71.1b
T2	19.9a	20.4a	13.0a	4.2a	98.4a
SE±	0.24	0.23	0.19	0.10	1.86
Interaction					
Spacing x staking	NS	NS	*	*	*

Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability. T1 = control (unstaked plants) T2 = staked plants NS= not significant
** = significant at 5% level of probability.*

Table 6: Interactions between spacing and staking on the: number of fruits per plant of cucumber, fruit yield per plant (kg) and fruit yield (t/ha) of Cucumber. Data pooled 2016 – 2017.

Treatment	Interaction between spacing and staking on the number of fruits per plant of cucumber		Interaction between spacing and staking on the fruit yield per plant of cucumber (kg)		Interaction between spacing and staking on the fruit yield (t/ha) of cucumber	
	Staking		**Staking**		**staking**	
Spacing (cm)	**T1**	**T2**	**T1**	**T2**	**T1**	**T2**
30x30	9.2f	12.4c	1.4e	3.2c	65.2h	76.7e
30 x 40	10.1e	11.2d	2.4d	3.5c	78.0d	89.32c
40x50	10.6e	15.0a	2.1c	5.5a	70.7f	129.4a
50x50	10.4e	13.4b	2.6c	4.5b	70.3g	98.3b
SE±	0.071		0.035		0.71	

T1 = control (un-staked plants) T2 = staked plants
Means followed by the same letter (s) within the same treatment group or column are not statistically deferent at 5% level of probability.

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GROWTH AND YIELD RESPONSE OF TIGER NUT (*Cyperus esculentu L*) VARIETIES TO POULTRY MANURE AND NPK FERTILIZER RATES

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ABSTRACT
The experiment on growth and yield response of tiger nut (Cyperus esculentu L) varieties to poultry manure (pm) and NPK fertilizer rates was carried out during the 2017 rainy season at the College of Agriculture Lafia research farm on growth parameters of tiger nut varieties. The treatment consisted of two levels of poultry manure (0 and 30 kg Pm ha^{-1}), three levels of NPK fertilizer (0, 20 and 40, kg NPK ha^{-1}) and three varieties of tiger nut (Black, Big-brown and Small-brown), these factors were factorially combined and laid out in a Randomised Complete Block Design (RCBD) replicated three times. Agronomic practices were carried out. Growth parameters of tiger nut varieties were significantly increase with the application of PM and NPK fertilizer rates. Poultry manure at 30 kg ha^{-1} and NPK at 40 kg ha^{-1} increased crop growth and yield and can be adopted by the farmers with any of the varieties depending on location and consumers preference.
Keywords*: Growth, Poultry manure, Varieties, NPK, Tiger nut*

INTRODUCTION

Tiger nut (*Cyperus esculentus*), known as yellow nut grass, ground almond (Africa), and chufa (Spain), is a perennial sedge with underground tubers and the top of the plant is grass-like leaves. In Nigeria, it is known as “Aya” in Hausa,”Ofio” in Yoruba and “Akiausa” in Igbo (Oladele *et al*., 2009), it is a cosmopolitan perennial crop of the same genus as the papyrus plant and belongs to the sedge family cyperaceae [Bamishaiye and Bamishaye, 2011]. It is a tuber that grow freely and is consumed widely in Nigeria, other parts of west Africa, east Africa, parts of Europe particularly Spain as well as in the Arabian Peninsula (Abaejoh *et al*., 2006). Tiger nut milk was classified as medicinal drink due to its been highly energetic and diuretic, rich in mineral, predominantly phosphorus and potassium and also vitamins C and E (Abaejoh *et al*., 2006). The local non-alcoholic drink has its advantage of not containing sodium, lactose sugar, casein protein, gluten, cholesterol and therefore suitable as beverage for diabetics (Belewu and Abodunrin, 2006). Tiger nut is recognised for its health benefits as it is high in fibre, protein, natural sugar soluble glucose and oleic acid with high energy content, they are rich in mineral phosphorus, potassium, vitamins E and C. Tiger nut help to prevent heart attack, thrombosis and cancer of the colon. They are beneficial to diabetics, help in reduction of cholesterol and are ideal for healthy eating.

The savannah soils of Nigeria are low in nutrients levels therefore fertilizer application is very important as it increase crop growth and prevent failure in poor nutrient soils. Poultry manure (PM) and NPK fertilizer are important in crop growth, and it is a constituent of chlorophyll in plants. There is need for PM and NPK fertilizer recommendation for tiger nut to boost it growth as there is scanty information on nutrient requirement

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of tiger nut production. This research is carried out to determine growth of tiger nut varieties in response to PM and NPK fertilizer rates.

MATERIALS AND METHOD

The research was carried out during the 2017 rainy season at the College of Agriculture Lafia research farm. The treatment consisted of two levels of poultry manure (0 and 30 kg pm ha^{-1}), three levels of NPK fertilizer (0, 20 and 40, kg N ha^{-1}) and three varieties of tiger nut (Black, Big-brown and Small-brown). A factorial combination of the factors was carried out and arrange in a Randomised Complete Block Design (RCBD) replicated three times. The size of the plot was 12 m^2 (4 mx3 m). The net plot with net area of 6 m^2 plot consisted of two inner rows of the plot. The experimental site was cleared, harrowed and ridged at 75 cm apart. Two seeds per hole were sown manually at a spacing of 15 cm, NPK fertilizer (15; 15; 15) was split applied at two and six weeks after sowing (WAS) while poultry manure (PM) was applied once a week before sowing. Cultural practices were carried out to ensure proper growth of the crop.

Growth characters measurement were conducted on five tagged plants at 8 and 10 WAS on Plant height (cm) which was determined by measuring the height of each tagged plants in the net plots from the ground level to the growing tip of the main stem plant, with a meter rule and the mean was recorded. The number of leaves and tillers per plant was determined by counting on each tagged plant and the mean worked out and recorded, yield ha^{-1} was determined by converting yield per net plot to hectare (kg/ha). The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967), the least significant difference (LSD) was used to separate differences among treatment means.

RESULTS

Table 1 shows the influence of poultry manure and NPK fertilizer rates on plant height, number of leaves, number of tillers and fresh yield ha^{-1} of tiger nut varieties.

From the result on plant height (cm), increasing PM application significantly increased the height of the plants at 8 and 10 WAS. Application of 20 and 40 kg NPK ha^{-1} are statistically similar and resulted in taller plants compared to the control at all the sampling period. Varieties showed non significant difference in plant height at 8 and 10 WAS. There was no significant interaction observed between the treatments.

At 8 WAS, 30 kg ha^{-1} PM application resulted in significantly more number of leaves than the control treatment. At 10 WAS, increasing PM rate from 0 to 30 kg ha^{-1} did not significantly increased number of leaves. Application of NPK rates at 8 WAS showed non significant difference on number of leaves of tiger nut, but at 10 WAS, 20 and 40 kg ha^{-1} are statistically similar and resulted in more number of leaves than the control. Varieties showed non significant difference on number of leaves at 8 WAS, at 10 WAS Black and Small-brown are statistically similar and resulted in significantly more number of leaves than Big-brown. There was no significant interaction observed between the treatments.

On number of tillers, 30 kg pm ha^{-1} resulted in significantly more tillers than the control at both sampling period. 20 and 40 kg NPK ha^{-1} are statistically similar and resulted in more number of tillers than 0 kg NPK ha^{-1}. Black and Small-brown are statistically same and resulted in significantly more number of tillers compared to Big-brown. There was no significant interaction observed between the treatments.

The result on fresh yield ha^{-1} showed that 30 Kg pm ha^{-1} resulted in significantly more yield than 0 kg pm. Increasing NPK rates from 0 to 40 kg ha^{-1} significantly increased fresh yield ha^{-1}. Black variety resulted in significantly more yield followed by Small-brown and then Big-brown. There was no significant interaction observed between the treatments.

DISCUSSION

The increased in growth characters as a result of applied PM and NPK fertilizer rates could be due to the elements in PM and NPK which help in promoting vegetative growth resulting in higher LA and thus higher assimilate production. Nitrogen is an important constituent of chlorophyll, amino acid, nuclei acid, enzymes; hence it is essential in plant growth and development (Agbede, 2009). also it could be as a result of phosphorus vital role in plant development and growth. Dauda *et al.* (2015), reported a significant increase in growth parameters due to increased P fertilization from 40 to 80 kg P ha^{-1}

The non significant differences among the varieties, observed on plant height could be that the varieties have reached their optimum growth height at the sampling periods. The significant differences in number of leaves per plant, number of tillers per plant, and fresh yield ha^{-1} could be due to the varietal differences of each variety and response to environmental factors such as temperature, soil factor, soil pH and cultural practices. The efficiency with which the varieties respond to environmental treatment differs and the efficiency of photosynthesis is often associated with the degree of vegetative growth of the plant. This result supported the findings of Fawzy *et al*. (2011), who reported that growth of any crop is a function of its genotype expressed under growing environmental conditions.

. In conclusion, poultry manure at 30 kg ha^{-1} and NPK at 40 kg ha^{-1} increased crop growth and yield. This can be adopted by the farmers with any of the varieties depending on location and consumers preference..

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Table 1: Influence of Poultry manure and NPK on plant height, number of leaves, number of tillers of Tiger nut at 8 and 10 WAS during 2017 rainy season at Lafia

	Plant height (cm)		Number of leaves		Number of tillers		
Treatment	8 WAS	10 WAS	8 WAS	10 WAS	8 WAS	10 WAS	Fresh yield kg ha^{-1}
Poultry manure(kg ha^{-1})							
0	42.64b	63.90b	44.50b	56.00b	12.57b	15.85b	389.22b
30	58.96a	72.00a	54.00a	68.50a	16.75a	19.32a	604.20a
LSD	3.18	5.00	8.30	8.81	3.31	2.81	42.66
NPK rate (kg ha^{-1})							
0	53.63b	63.03b	46.00	51.90b	11.00b	12.74b	513.18c
20	62.24a	78.60a	58.80	67.50a	16.58a	18.58a	578.55b
40	65.04a	72,52a	62.60	78.20a	17/60a	20.30a	800.24a
LSD	3.89	6.12	10.20	10.80	4.06	3.15	52.23
Variety							
Black	52.86	60.04	46.10	52.70a	13.00a	18.25a	1059.06a
Big-brown	54.92	63.20	38.10	41.20b	8.09b	11.00b	502.89c
Small-brown	55.82	66.40	45.30	55.00a	15.78a	15.30a	677.72b
LSD	3.89	6.12	10.20	10.80	4.06	3.45	52.23
Interaction							
Pm x NPK	NS	NS	NS	NS	NS	NS	NS
Pm x V	NS	NS	NS	NS	NS	NS	NS
NPK x V	NS	NS	NS	NS	NS	NS	NS
Pm x NPK x V	NS	NS	NS	NS	NS	NS	NS

Means followed by same letter(s) in a column and treatment group are not statistically different at 5% level of probability using LSD. NS = Not significant. WAS= weeks after sowing

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EFFECT OF ANTITRANSPIRANTS ON THE GROWTH AND YIELD OF MOISTURE STRESSED TOMATO (*Solanum lycopersicon* L.) AT KADAWA IN SUDAN SAVANA OF NIGERIA

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Abstract
Salicylic acid and Benzoic acid are antitranpirants usually used to reduce the rate of moisture loss and increase productivity of irrigated crops. In order to validate the antitranspiracy of Salicylic and Benzoic acids, field experiments were conducted during the two successive dry Seasons of 2011/2012 and 2012/2013 at the Agricultural Research Station Farm, Kadawa (11 38 40.3 N, 8 25 53.9 E) 498 m elevation above sea level. The treatments consisted of two antitranspirants at four concentrations each (0, 200, 400 and 600 ppm) and three moisture stress stages (vegetative, flowering and fruit setting). Antitranspirants and moisture stresses were assigned to the main plot and concentrations were used as sub–plot treatment. These were replicated three times and laid out in a split-plot design. The gross plot size was 3.6 m x 3.0 m (10.8 m^2) consisting of 6 rows of 3 m length, while the net plot size was 1.2 m x 1.8 m (2.16 m^2) consisting of 2 inner most rows. Data were taken on number of branches plant $^{-1}$, leaf area plant $^{-1}$, total dry matter and crop growth rate and fruit yield. Data generated were analysed using SAS. The results of the study revealed that application of Salicylic acid at 600 ppm significantly enhanced number of branches, leaf area, total dry matter and crop growth rate than application of Benzoic acid. Better results were observed from the plants that were sprayed with Salicylic acid at fruit setting stage. Imposing stress at vegetative stage had higher total fruit yield than other stages. Flowering and fruiting stages were found to be the critical growth stages for moisture stress of tomato. Foliar application of 400 ppm of Salicylic acid at fruit setting stage appeared to promote tomato yield in the study area.

Key words: *Antitranspirant, moisture stress, growth characters, tomato and yield.*

INTRODUCTION

Tomatoes are one of the most widely eaten vegetables in the world. Their popularity stems from the fact that it can be eaten fresh or in multiple of processed forms. It is a versatile health product and due to its equally versatile preparation option, there is really no reason to neglect the tomato as part of a healthy diet. Tomato is a rich source of vitamins A, B and C with acidic properties that bring out other flavour (Rakesh and Adarsh, 2010). In the recent decades the consumption of tomatoes have been associated with the prevention of several diseases (Wilcox *et al.,* 2003, Sharoni and Levi, 2006) mainly due to the content of antioxidants including carotenes, ascorbic acid and phenolic compounds (Periago *et al.,* 2009). The red pigment contained in tomato is called lycopene. Cultivation of tomato is now widespread throughout the temperate and tropical climate (Harlan, 1984). It is among the most important vegetable crops in Nigeria. The total production of this crop in this country has shown a marked increase since it became the most profitable crop providing a high income to small scale farmers compared to other vegetable crops. It is currently the most important commercial vegetable grown in Nigeria. The rain fed production (June – September) is also important due to continuous demand for fresh tomato, but generally limited by pests and diseases that are prevalent under such humid and warm conditions (Quinn, 1980). The cultivated tomato reached its present status after a long period of domestication and it is now grown throughout the temperate and tropical climates (Harvey *et al.,* 2002).The area of major production is the Northern part of the country, between latitude 8^0 –

13^0N, but the greatest market is mostly in the South and other neighbouring countries (Amans *et al*., 1986).

MATERIALS AND METHOD

The experiment was conducted for the two successive dry seasons of 2011/2012 and 2012/2013 at the Teaching and Research Farm of Faculty of Agriculture, Bayero University, Kano (11 97 98.6 N, 8 42 03.7 E) 475 m above sea level. The treatments consisted of two antitranspirants (Benzoic and Salicylic acids) at four concentrations each (0, 200, 400 and 600 ppm) and three moisture stress stages (vegetative, flowering and fruit setting). The experiment was laid out in a split-plot design and replicated three times. The land was ploughed, harrowed and prepared into plots of slightly sunken beds of 3.6 m x 3.0 m (10.8 m^2) sizes. Paired rows of beds were separated by 0.75 m wide irrigation channels between the plots. Before removing the seedlings from the nursery, the beds were thoroughly irrigated and seedlings were uprooted using a small hand hoe and then transplanted at a spacing of 60 cm x 60 cm. Salicylic and Benzoic acids were sprayed to the foliage using a hand sprayer at vegetative, flowering and fruit setting stages at the rate of 0, 200, 400 and 600 ppm equivalent to 0.2, 0.4 and 0.6 g L^{-1} of water. List parameters that data were collected and how it was analysed.

RESULTS

Table 1 shows that the Antitranspirants had no significant effect on number of branches $plant^{-1}$ and the leaf area of the moisture stressed tomato. However, the effect of stress was observed to be significant on number of branches $plant^{-1}$ in 2012 season where plants that were stressed at fruiting stage had more number of branches $plant^{-1}$ (9.39) although statistically at par with those stressed at flowering stage (8.96) while those stressed at vegetative stage had fewer number of branches $plant^{-1}$ (7.10). Similar trend was observed in 2013 and combined seasons. Significant difference was observed for concentration on the number of branches $plant^{-1}$ in 2013 and combined where application of 600ppm produced plants with more number of branches $plant^{-1}$ (12.90) and (10.71), respectively while those that received 0ppm had fewer number of branches $plant^{-1}$ (11.38) and (9.74), respectivly. Plants stressed at flowering stage had wider leaf area (5.69 cm^2) than fruiting (4.65 cm^2) and vegetative (4.37 cm^2) stages, respectively in 2012 season which were at par. Similar trend was observed in 2013 and combined season with fruiting stage having the higher values. Concentration effect was significant in both seasons and combined where plants foliar sprayed with 200ppm had wider leaf area (5.46 cm^2) while those sprayed with 0ppm had narrow leaf area (4.39 cm^2) in 2012 saeason but not at par with 400ppm and 600ppm concentrations. Similar trend was observed in 2013 and combined season but 0ppm was at par with 400ppm and 600ppm concentrations. Interaction effect was significant between stress and concentration on number of branches per plant in 2013 and combined season, and leaf area of moisture stressed tomato only in 2013 season.

Table 2 shows the effect of Antitranspirants on dry matter and crop growth rate of moisture stressed tomato. There was significant difference between the anittranspirants on dry matter of moisture stressed tomato in both seasons and combined where plants that were sprayed with salicylic acid had highest dry matter (121.00g), (161.30g) and (141.07g) than benzoic acid (100.11g), (113.88g) and (107.00g) in 2012, 2013 and combined season, respectively. Stress was significant

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in both season and combined where in 2012 season, plants that were stressed at fruit setting stage recorded the highest dry matter (126.08g) while those stressed at vegetative stage produced the lowest dry matter (100.68g). Similar trend was observed in 2013 where plants stressed at fruiting stage had the highest dry matter (234.65g) and lowest at vegetative stage (83.44g) and in combined seasons, highest dry matter (180.37g) was observed at fruiting stage and lowest dry matter at vegetative stage (92.06g). In the 2012 season, plants that were sprayed with 600ppm concentration recorded the highest dry matter (114.16g) while those sprayed with 200ppm had (107.35g) lowest dry matter which was statistically at par with 0ppm (109.78g). Similar trend was observed in 2013 and combined seasons. Interactions between treatments was significant on dry matter of moisture stressed tomato.

Antitranspirants had significant effect on crop growth rate of moisture stressed tomato only in 2013 where plants that were sprayed with Benzoic acid recorded the highest crop growth rate (3.88) than those sprayed with Salicylic acid (2.56). The effect of stress was significant on crop growth rate only in 2013 and combined seasons where plants that were moisture stressed at fruiting stage had the highest crop growth rate (3.59) while those stressed at flowering stage had the lowest crop growth rate (2.40) although statistically at par with those stressed at vegetative stage (2.66). Similar trend was observed in combined seasons. The concentration effect on crop growth rate of moisture stressed tomato was significant only in 2012 and 2013 seasons where plants that received 400ppm recorded the highest crop growth rate (3.74), although statistically at par with 200ppm (3.73) while plants that received 0ppm had the lowest crop growth rate (2.80). Similar trend was observed in 2013 season. Interaction between treatments was significant on crop growth rate in 2013 (Table 2).

Table 3 shows the effect of Antitrnapirants on the fruit yield of moisture stressed tomato.Antitranspirants was significant only in 2013 where plants that were sprayed with Benzoic acid recorded the highest fruit yield (3.76 t ha^{-1}) while those that were sprayed with Salicylic acid produced the lowest fruit yield (3.06 t ha^{-1}). The effect of stress was not significant on the fruit yield of moisture stressed tomato. However, concentration effect was significant only in 2012 season and combined where plants that received 400ppm recorded the highest fruit yield (3.98 t ha^{-1}) although statistically at par with 200ppm (3.74 t ha^{-1}) while the lowest fruit yield (2.62 t ha^{-1}) was recorded from the plants that were sprayed with 0ppm. Similar trend was observed in the combined season.

DISCUSSION

There was no difference between the two antitranspirant in both seasons and combined on number of branches $plant^{-1}$ of tomato. This implies that the antitranspirants had no effect on number of branches. This is in contrast with the findings of El-Gamassy *et al.* (1987) who reported that the use of Altar B-9 resulted in more number of branches than those treated with Cycocel (CCC). Salicylic acid gave higher leaf area in both seasons than Benzoic acid. Higher performance of Salicylic acid than Benzoic acid could be attributed to the differences of the active ingredient in the formulation of the antitranspirants. The active ingredient in Benzoic acid was 0.3 kg a.i while that of Salicylic acid was 0.95 kg a.i. Similar result was observed by Latimer (1992)

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who reported that application of GA_3 increased leaf area. This findings are in contrast with the results of El-Kobbia and Ibrahim (1986) who did not observe any effect on leaf area of tomato plants sprayed with Epoxylin seed oil and vapour guard antitranspirants. Total dry matter increased with Salicylic acid than Benzoic acid in both seasons. This may probably be due to the fact that, Salicylic acid might have affected assimilate transportation to the various organs positively than the Benzoic acid. Irmak *et al.* (1999) found that plant development and dry matter production for the vegetative parts of tomato plants were increased by antitranspirants. Application of Salicylic at fruit setting stage had higher dry mater possibly because of higher number of branches recorded by this antitranspirant at this stress stage. Gu *et al.* (1996) had earlier reported that water stress and antitranspirant GLK-8924 interacted on tomato to affect plant growth rate and hence dry matter. Salicylic acid had higher crop growth rate than Benzoic acid. This higher performance of Salicylic acid than Benzoic acid could be attributed to the higher leaf area and higher total dry matter obtained from plants that were sprayed Salicylic acid. Salicylic acid had produced plants with the highest relative growth rates than Benzoic acid. This results supports the findings of Goreta *et al.* (2007) who reported that relative growth rate of pepper was reduced by aminoethoxyvinlglycine treated plants at 40% and 50% respectively, compared with control plants while enhanced relative growth rate was found after aminoethoxyvinlglycine and vapour guard application. The higher performance of Salicylic acid in terms of net assimilation rate of tomato than Benzoic acid could be attributed to the net effect of Salicylic acid on crop growth rate and the relative growth rate. This result is in contrast with that of Cantore *et al.* (2009) who reported that application of Kaolin based particle film on tomato reduced net assimilation rate by 26%. Application of 200 ppm of antitranspirant produced plants with higher total fruit yield than when no antitranspirant was applied. This could be associated with the effect of this treatment on characters like fruit weight and fruit diameter which are all positively correlated with fruit yield. MacDonald *et al.* (2010) reported that preconditioning with 10 mg L^{-1} Amboil resulted in an increase of 65.1 % in number of tomatoes on each plant and 44 % in tomato mass (weight) which resulted to an increase of fruit yield by 143 %.

CONCLUSION

The results of the study revealed that application of Salicylic acid at 600 ppm significantly enhanced number of branches per plant, leaf area per plant, total dry matter and crop growth rate than application of Benzoic acid. Better results were observed from the plants that were sprayed with Salicylic acid at fruit setting stage. Imposing stress at vegetative stage had higher total fruit yield than other stages. Flowering and fruiting stages were found to be the critical growth stages for moisture stress of tomato. Foliar application of 400 ppm of Salicylic acid at fruit setting stage appeared to promote tomato yield in the study area.

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Table 1. Effects of Antitranspirants on Number of Branches Plant^{-1} and Leaf Area (cm^2) of Moisture Stressed Tomato at Kadawa in 2012, 2013 Dry Seasons and Combined.

Treatments	Number of Branches plant^{-1}			Leaf Area cm^{-2}		
	2012	2013	Combined	2012	2013	Combined
Antitranspirants (A)						
Benzoic acid	8.02	12.23	10.12	4.90	5.05	4.98
Salicylic acid	8.95	11.97	10.46	4.89	4.69	4.79
Level of significance	NS	NS	NS	NS	NS	NS
SE±	0.350	0.354	0.885	0.200	0.200	0.131
Stress (S)						
Vegetative	7.10b	4.80b	5.95b	4.37b	4.28c	4.32c
Flowering	8.96a	15.74a	12.35a	5.69a	5.43a	5.56a
Fruit setting	9.39a	15.75a	12.57a	4.65b	4.91b	4.78b
Level of significance	**	**	**	**	**	**
SE±	0.350	0.354	0.885	0.200	0.200	0.131
Concentrations ppm (C)						
0	8.11	11.38c	9.74b	4.39c	4.70b	4.55b
200	8.73	12.41ab	10.57a	5.46a	5.46a	5.46a
400	8.57	11.70bc	10.14ab	4.84b	4.74b	4.79b
600	8.53	12.90a	10.71a	4.90b	5.59b	4.75b
Level of significance	NS	*	*	**	**	**
SE±	0.240	0.298	0.723	0.135	0.150	0.107
Interactions (I)						
A x S	**	NS	NS	NS	NS	NS
A x C	NS	NS	NS	NS	NS	NS
S x C	NS	*	*	NS	*	NS
A x S x C	NS	NS	NS	NS	NS	NS

*Means followed by the same letter (s) in a column are not statistically different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; **= significant at 1%; NS = not significant*

Table 2. Effects of Antitranspirants Dry Matter (g) and Crop Growth Rate (gwk^{-1}) of Moisture Stressed Tomato at Kadawa in 2012, 2013 Dry Seasons and Combined.

Treatments	Dry Matter (g)			Crop Growth Rate (gwk^{-1})		
	2012	2013	Combined	2012	2013	Combined
Antitranspirants (A)						
Benzoic acid	100.11b	113.88b	107.00b	3.39	3.88a	3.63
Salicylic acid	121.00a	161.13a	141.07a	3.21	2.56b	2.88
Level of significance	**	**	**	NS	**	NS
SE±	3.030	3.030	11.150	0.197	0.171	0.393
Stress (S)						
Vegetative	100.68c	83.44c	92.06b	3.38	2.66b	3.02b
Flowering	104.90b	94.34b	99.67b	3.16	2.40b	2.78b
Fruit setting	126.08a	234.65a	180.37a	3.36	3.59a	3.97a
Level of significance	**	**	**	NS	**	*
SE±	3.030	3.030	11.150	0.197	0.171	0.393
Concentrations ppm (C)						
0	109.78b	107.83d	108.81b	2.80b	2.69b	2.86
200	110.93ab	136.71c	123.82a	3.73a	2.82b	3.21
400	107.35b	160.79a	134.07a	3.74a	4.19a	3.86
600	114.16a	144.69b	129.43a	2.92ab	3.16b	3.04
Level of significance	*	**	*	*	*	NS
SE±	2.210	2.210	9.100	0.242	0.303	0.321
Interactions (I)						
A x S	**	**	**	NS	**	NS
A x C	**	**	**	NS	*	NS
S x C	**	**	*	NS	NS	NS
A x S x C	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) in a column are not statistically different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; **= significant at 1%; NS = not significant

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Table 3. Effects of Antitranspirants on the Fruit Yield (t ha^{-1}) of Moisture Stressed Tomato at Kadawa in 2012, 2013 Dry Seasons and Combined.

Treatment	Fruit Yield (t ha^{-1})		
	2012	2013	Combined
Antitranspirants (A)			
Benzoic acid	3.44	3.76a	3.60
Salicylic acid	3.52	3.06b	3.29
Level of significance	NS	*	NS
SE±	0.329	0.152	0.266
Stress (S)			
Vegetative	3.66	3.38	3.52
Flowering	3.48	3.52	3.50
Fruit setting	3.30	3.33	3.31
Level of significance	NS	NS	NS
SE±	0.329	0.152	0.266
Concentrations ppm (C)			
0	2.62b	3.03	2.83b
200	3.74a	3.62	3.68a
400	3.98a	3.57	3.77a
600	3.57a	3.43	3.50a
Level of significance	*	NS	*
SE±	0.225	0.174	0.217
Interactions (I)			
A x S	*	NS	NS
A x C	*	NS	NS
S x C	NS	NS	NS
A x S x C	*	NS	NS

Means followed by the same letter (s) in a column are not statistically different at 5% level of probability using Student-Newman Keuls Test. *=significant at 5%; **= significant at 1%; NS = not significant

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AUTHORSHIPAND CONFERENCE ATTENDANCE BY HORTICULTURAL SCIENTISTS FROM 1996 – 2007 IN NIGERIA

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ABSTRACT
There are many factors that can motivate or demotivate conference attendance in developing countries such as Nigeria. Some conferences are general and can attract large attendants such as science associations or agricultural associations. Can similar things be happening in specialised fields like horticulture? Hence, Nigerian Horticultural conference attendance vis venue of conference among researchers, authorship pattern as well as contributions of authors from various institutions were investigated in this study. A total of five hundred and thirty nine (539) articles published in HORTSON proceedings from 1996 to 2007 were analysed. It was observed that collaborative research has preference over solitary research during the period under consideration in this study. Seventy-six percent (76%) of the articles published from 1996 to 2007 were co-authored. The Universities (41.9%) had the highest contributions closely followed by Nigerian Research Institutes (31.5%) in terms of number of publications. The locations of the conference do not reduce the number of participants. Conference participants of 1996 held at Ago-Iwoye, Ogun State recorded the highest number of participants, closely followed by Kano State with 129 participants in the year 2004. To encourage cross fertilization of ideas, students, pupils researchers as well as senior scientists should be encouraged to attend and participate more in HORTSON conference. This will increase productivity of horticultural scientists.
Keywords: *Conference participants; Horticulture; Authorship pattern; Nigeria*

INTRODUCTION

Conference attendance plays a significant role in enriching the professional development of scientists and is highly priced among scientists globally. Participation in conferences enables scientists to improve their articles by getting feedback through questions and discussions of other researchers in the conference. It helps researchers to disseminate their research findings and extend their professional network (Brogaard *et al.*, 2014, Reinartz and Urban, 2016). Batson (2018) asserted the benefit of attending professional conferences to include professional development among others. This, according to the author, will significantly enrich the professional life of an attendee thereby giving him or her satisfaction, networking and informal sharing among colleagues. This is a vital valuable experience of a conference. Up–to date information on new discoveries are also discussed and disseminated to delegates. Zhanga *et al.* (2007) stated that "conference program can satisfy the attendees' by offering them an opportunity to keep up with any changes in their professional field and learn new skills". Tonford *et al.* (2007) gave five factors that have impact on conference attendees as program, networking, location, cost and external activities. Research on authorship pattern and publications is a prominent area of knowledge generation by library professionals (Arya and Sharma, 2018). It is of importance that pattern of authorship in a very important research field like horticulture be examined. This paper therefore seek to identify research articles contributions by year at HORTSON conferences. Identify the degree of collaboration by author(s)., examine contributions by Institutions and find out the relationship between venue of

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conference and number of attendees at the conference.

METHODOLOGY

Horticultural Society of Nigerian was founded in 1977. A total of five hundred and thirty nine (539) articles published in Horticultural Society of Nigeria (HORTSON) proceedings from 1996 to 2007 were analysed. The factors examined include authorship trend, conference venue, conference attendance, date of conference, and contributions of various Institutions. Data were generated based on the objective of the study and analysed using descriptive statistics.

RESULTS AND DISCUSSION

This study investigated the intellectual activities of scientists published in the conference proceedings of the Horticultural Society of Nigeria. The study cover a ten year period from 1996 to 2007 (1999 and 2006 exempted due to some inconsistencies observed in the proceedings, relative to the rest).Table 1 presents the year-wise distribution of the number of articles published. A total of five hundred and thirty nine (539) articles were published. The lowest number of articles was published in 2000 while the year with highest articles, 78 (14.5%) was in the year 2005. The contributions with reference to the number of papers reached a high point in year 2000.. This shows that the founding fathers of the Association were able to marshal their efforts in bringing together very good number of contributors to the conferences at the not too distant from its inception

In Table 2, conference of 1996 held at Ago-Iwoye, Ogun State from 1st – 4th April, 1996 recorded the highest number of participants (135), closely followed by Kano State with 129 participants in the year 2004. Hence, location/distance from places of residence does not seem to affect participation of members in HORTSON conferences. More so, HORTSON draws her members from all over Nigeria. The findings of Dunjic *et al*. (2012) show that networking, gaining knowledge and conference program are key factors that affects conference attendance.

Table 3 reveals that joint authorship is prevalent among Horticultural Scientists. It can be deduced from the Table that out of five hundred and thirty nine (539) published articles, four hundred and ten (76%) were co-authored, hence the publications could be said to be skewed towards joint authorship**.** It has possibility of being more enriched going by the aphorism-“two heads are better than one”. The findings of the study also revealed that year 2001 had the highest single authored publications (37.3%) while year 2004 had the highest multiple authored publications (88.2%).Tables 4 and 5 showed the contribution of authors based on their institutions. The analysis revealed that Nigerian Universities (41.9%) had the highest contributions closely followed by Nigerian Research Institutes (31.5%).

CONCLUSION

Horticultural Society of Nigerian proceedings under study have shown collaboration among scientists. The two highest number of attendance at HORTSON conferences during the years under review are 1996 (Ago Iwoye, Ogun State, South-western Nigeria) and 2004 (Kano, Kano State, North-western Nigeria) suggesting that venue of the conferences had nothing to do with the number of scientists attending at the conferences.

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Table1: Year-wise distribution of articles published in HORTSON conference from 1996 to 2007

S/NO	Year	Venue of Conference and Date	Total number of participants
1	1996	Ago-Iwoye, Ogun State. 1-4 April,1996	135
2	1997	NationalHorticultural Research Institute, Idi-Ishin, Jericho, Ibadan, Oyo State.6th-11th April.	81
3	1998	University of Agriculture, Abeokuta, Ogun State.7th-10th September.	81
4	2000	Institute for Agricultural Research, Samaru, Ahmadu Bello University, Zaria. May 28-June 1	81
5	2001	University of Nigeria, Nsukka, Enugu State. May 28-June 1.	77
6	2002	National Horticultural Research Institute, Idi-Ishin, Jericho, Ibadan, Oyo State.14th-17th May.	95
7	2003	National Horticultural Research Institute, Idi-Ishin, Jericho, Ibadan, Oyo State.10th-13th November.	118
8	2004	Duala Hotel, Hadejia Road, Kano, Kano State.4th-9th July.	129
9	2005	Rivers State College of Education, Rumuolumeni, Port-Harcourt. 18th-22nd September.	85
10	2007	National Horticultural Research Institute, Idi-Ishin, Jericho, Ibadan. Oyo State. 4th-8th November.	99
	Total		981

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Table 2: Venues of HORTSON conferences, date and number of participants from 1996 to 2007

S/No	Publication Year	Total articles published	Percentage (%)
1	1996	67	12.4
2	1997	59	10.9
3	1998	52	9.6
4	2000	32	5.9
5	2001	51	9.5
6	2002	69	12.8
7	2003	46	8.5
8	2004	34	6.3
9	2005	78	14.5
10	2007	51	9.5
Total		539	100

Table3: Single authored *vis* multi authored publications in HORTSON conference from 1996 to 2007

S/NO	Year	Single authored	Joint authored	Total articles published	%of Single authored articles	% of Joint authored articles
1	1996	24	43	67	35.8	64.1
2	1997	20	39	59	33.8	66.1
3	1998	19	33	52	36.5	63.5
4	2000	8	24	32	25	75
5	2001	19	32	51	37.3	62.7
6	2002	17	52	69	24.6	75.4
7	2003	6	40	46	13.0	86.9
8	2004	4	30	34	11.8	88.2
9	2005	7	71	78	8.9	91.0
10	2007	5	46	51	9.8	90.1
	Total	129	410	539	23.9	76.1

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Table 4: Contributions by Institutions in HORTSON conference from 1996 to 2007

S/NO	Year	Universities	Research Institutes	College of Agriculture/ Horticulture	College of Education	Others
1	1996	99	17	Nil	Nil	19
2	1997	29	42	Nil	Nil	10
3	1998	30	38	Nil	Nil	13
4	2000	40	26	Nil	Nil	15
5	2001	30	35	5	2	5
6	2002	32	33	7	2	3
7	2003	48	26	7	1	36
8	2004	33	23	21	Nil	52
9	2005	26	27	7	5	20
10	2007	37	36	9	2	15
	Total	404	303	56	12	188

Table5: Percentage contributions by Institutions to HORTSON conferences from 1991 to 2007

S/NO	Institutions	Percentage (%)
1.	Universities	41.9
2	Research Institutes	31.5
3	College of Agriculture/ Horticulture	5.8
4	College of Education	1.2
5	Others	19.5
Total		100

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APPRAISAL OF EFFECT OF CAPACITY BUILDING ON ACQUISITION OF KNOWLEDGE AND SKILL AMONG MANGO VALUE CHAIN ACTORS FROM SELECTED GEO-POLITICAL ZONES IN NIGERIA

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Abstract
Value chain approach is one of the important ways of developing agricultural sector in Nigeria. In order to reap full benefits through value chain in mango sub-sector, additional skills through appropriate training and empowerment are required by farmers and other stakeholders. The study was carried out during a training programme conducted on mango value chain in Kwara State. It was designed in form of training of trainers thus participants were drawn from North-Central, South South, South West, North West and North East geopolitical zones of the country. Participants were subjected to both pre and post training knowledge assessment. Data were collected through the means of structured interview schedule from fifty-nine trainees Descriptive and inferential statistics were used for data analysis. The results of the study showed that most (67.8%) of the respondents were male with average age of 39 years and were educated. Post-knowledge mean scores of respondents were more than their pre knowledge mean scores in all sessions considered along mango value chain. T-test result revealed a significant difference in pre-training and post-training knowledge scores of trainees in mango nursery and orchard management (t=14.56, p = 0.000), economics and record keeping of mango (t=4.145,p = 0.000), mango post-harvest handling and safety (t=7.94, p = 0.000) and mango value chain (t=11.091, p = 0.000). It was recommended that more capacity building programme should be organized for dissemination of appropriate knowledge among horticultural stakeholders and trainees should be encouraged to practice the acquired skill accordingly through adequate empowerment strategies.
Key words: *Training, Knowledge, Skill acquisition, Stakeholders, mango value chain*

INRODUCTION

Capacity building is defined as the process by which individuals are equipped with skills and knowledge they need to perform effectively and efficiently in their businesses (Azikiwe, 2008). It is planning for people to acquire knowledge and advanced skills that are critical to a country's economic growth, its standard of living and individual empowerment. They are planned programmes that will impart skills which will enable the recipient put the knowledge and skills acquired into productive uses to solve wide range of individual and national problems (Nwazor, 2012). Capacity building comes through training which could be pre-employment or on-the-job training. Training is a term described as the process of acquiring the essential skills required for a person to perform certain job better (Krishnamurthy *et al*, 2015). It targets specific goals, and puts emphasis on broader skills, which are applicable in a wide range. Training involves the processes of teaching, informing and educating people. Training programme have to meet the training needs of the participants.

Capacity building is needed in developing countries, like Nigeria, where there is high rate of unemployment. According to Uddin *et al* (2013), the unemployment in the country increased from 21.1% in 2010 to 23.9% in 2011. From 2011 to 2013 there is an

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increase of 16% unemployment growth rate in Nigeria.

Value chain is a concept described as entire range of activities required to bring a product from initial input-supply stage through production to consumption (UNIDO, 2009). Value chain is increasingly becoming popular as a way of developing agricultural sector in Nigeria. Additional skills in this area are vital for farmer and other stakeholders in mango sub-sector to reap full benefits through value chain. Training in mango value chain will provide an opportunity for farmers and other actors in the chain to interact with professionals in the field, as well as receive opportunities for receiving new information as regard aspects of the chain. Their skills and knowledge will be more enhanced and increased through capacity building (Ekong and Ekong, 2016). Likewise, Uloko and Ejinkonye, 2010 remarked that when people are empowered through the acquisition of entrepreneurial skills, there is possibility that they will use the skills to create wealth. It is therefore necessary to train prospective stakeholders along the value chain. Upon this background, the training programme along mango value chain was organized and thereafter its impact on the participants' knowledge was evaluated. The specific objectives of this study were:

i. To ascertain the socio-economic characteristics of the trainees
ii. To determine the pre-training and post-training knowledge of trainees about mango value chain covering nursery and orchard management, economics and record keeping and post-harvest handling and safety.
iii. To determine the change in knowledge of trainees in mango value chain as a result of the training intervention.

METHODOLOGY

The study was carried out during the training programme on mango value chain organized by National Horticultural Research Institute (NIHORT), at Agricultural and Rural Management Training Institute (ARMTI) Ilorin, Kwara State in March 2018. All the 59 participants trained were used for the study. They were from five geopolitical zones comprising North central (Kwara and Kogi States), South South (Rivers State), South West (Oyo and Ogun state), North West (Kano and Kaduna) and South East (Anambra State). Participants were subjected to pre-training knowledge assessment at the beginning of the training and post-training assessment at the end of the training programme. Primary data were collected through the use of structured questionnaire administered to the 59 trainees. Data were analyzed using descriptive (frequency, percentage and mean) and inferential (T-test) statistics.

RESULTS AND DISCUSSION

Socio-economic characteristics of the trainees

The result presented in Table 1 shows that 67.80% of the respondents were male, indicating a male-dominating group. The mean age of the respondents is 39 years, indicating that they were young and economically active, and would be able to withstand the diverse and rigorous activities in mango value chain. Most (64.40%) of the respondents were married connoting some level of responsibility. About 52.6%, 30.5% and 3.4% of the respondents had tertiary,

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secondary and primary education respectively, an indication that they were literate. The educational level attained by the respondents was expected to enhance the application of the skill acquired during the capacity building and empowerment programme. This result is supported by the findings of Uloko and Ejinkonye (2010) and Adeduntan (2015).

Difference between pre-training and post-training knowledge score of participants in mango nursery and orchard management

Result of the t-test in Table 2 reveals a significant difference between mean value of pre-training and post-training knowledge scores of the trainees during the mango nursery and orchard training ($p<0.05$). The mean value for pre-score is 0.661 while the post-score is 5.203. It shows an increase of 687.14% in knowledge among participants after the mango nursery and orchard management training. Result of the t-test further reveals a significant difference ($t=14.56$, $p=0.000$) in pre and post training knowledge scores. It implies that the trainees acquired significant knowledge in mango nursery establishment and orchard management during the training exercise.

Difference between pre-training and post-training knowledge score of participants in economics of mango and record keeping

The mean value for pre knowledge score is 0.831 while that of the post knowledge-score is 1.644 signifying 97.83% increase in knowledge of trainees in economics of mango and record keeping.

A critical look at the t-test result also shows a significant difference ($t=4.145$, $p=0.000$) in pre-training and post-training knowledge scores of participants. It implies that the trainees acquired significant knowledge during the training on economic of mango and record keeping which may likely impact their business orientation in mango value chain.

Difference between pre-training and post-training knowledge score among respondents in post-harvest handling, value addition and safety

Pre-knowledge and post knowledge mean score of participants in post-harvest handling, value addition and safety in mango production are 0.457 and 1.915 respectively depicting a positive change in knowledge to the tune of 319.03%. In the same vein the t-test analysis reveals a significant difference ($t=7.944$, $p=0.000$) between pre-training and post-training knowledge score of participants (Table 4). The implication of this is that the trainees acquired significant knowledge during the training programme which may likely improve on quality of their products.

Difference between pre and post knowledge score among participants along mango value chain training

Generally, along mango value chain (production to post-harvest handling), there is improvement in mean knowledge of participants from 1.949 before exposure to training to 8.763 after the training activity signifying up to 349.62% increase in knowledge. Result of the t-test analysis at $p<0.05$ also shows a significant difference ($t=11.091$, $p=0.000$) between pre and post knowledge scores of participants along the commodity value chain (Table 5). It implies that the trainees acquired significant knowledge during the training on mango value chain.

CONCLUSION AND RECOMMENDATION

The study revealed that the respondents were young and economically active,

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and would be able to withstand the different activities in mango value chain. They were able to acquire knowledge after the training in all aspects of mango value chain captured during the capacity building workshop. Participation in training is a viable tool for improvement of knowledge and adoption of technologies among horticultural stakeholders. Therefore, more training should be organized and trainees should be empowered in order to practice the acquired skill.

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Table 1: Demographic characteristics of respondents

Variable	Frequency	Percentage
Sex		
Male	40	67.80
Female	12	20.30
No response	07	11.90
Total	59	100.00
Marital status		
Single	12	20.30
Married	39	66.10
No response	08	13.60
Total	59	100.00
Age (years)		
31-40	24	40.70
41-60	20	33.90
No response	15	25.40
Total	59	100.00
Mean $\approx$ 39		
Educational level		
Primary education	02	03.40
Secondary education	18	30.50
Tertiary education	31	52.50
No response	08	13.60
Total	59	100.00

Source: Field survey, 2018.

Table 2: T-test showing difference in scores of the trainees during mango nursery and orchard management training

Score	N	Mean value	Df	t-value	Sig.
Pre-score (Before training)	59	0.661	116	12.714	0.000
Post-score (After training)	59	5.203			

Table 3: T-test showing difference in scores of the trainees during economics of mango value chain and record keeping training

Score	N	Mean value	Df	t-value	Sig.
Pre-score (Before training)	59	0.831	116	4.145	0.000
Post-score (After training)	59	1.644			

Table 4: T-test showing difference in scores of the trainees during training on mango post-harvest handling, value addition and safety

Score	N	Mean value	Df	t-value	Sig.
Pre-score (Before training)	59	0.457	116	7.944	0.000
Post-score (After training)	59	1.915			

Table 5: T-test showing difference in scores of the trainees during mango value chain training

Score	N	Mean value	df	t-value	Sig.
Pre-score (Before training)	59	1.949	116	11.091	0.000
Post-score (After training)	59	8.763			

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Spatial Price Analysis of Pepper in Ezza South Local Government Area, Ebonyi State, Nigeria

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Abstract:
The study analysed the spatial price of pepper in Ezza South Local Government Area of Ebonyi State. Data were collected using structured questionnaires administered on 120 pepper marketers randomly selected from the 4 markets locations in the Local Government Area. Data collected were analyzed using simple regression, gross margin and factor analysis. The result of the analysis showed that there exists spatiality in the prices of pepper in the area. And that market locations, cost of transportation, availability of storage facilities, density of pepper buyers, market organization, and individual price fixing are the major factors influencing spatial price of pepper. The coefficient of multiple determination (R^2) 0.768, showed that about 77% of the total variations in the quantity of pepper sold was explained by spatial price of pepper in the area. Despite the spatiality of prices in the markets the coefficients of elasticity in each of the market locations were elastic; implying that, in every ₦1 increase in the price of pepper will result in a unit increase in the quantity of pepper marketed. However, the individual market analysis shows that marketing of pepper is most profitable in "Eke Imoha" market. However, the study recommended the provision of marketing infrastructures such as good roads to enhance accessibility of the markets and easy delivery of pepper to the point of demand.
Key: Spartial price, Pepper, Marketers, Market Location, Elastic

Introduction

Agricultural commodity prices vary between locations and markets. This is a pure natural phenomenon. Price variation is necessary for the existence of a market, as it creates the incentives that attract market players to engage in trade. Spatial price analysis is an important area of discuss in the structure of markets (Ravallion, 1986). Thus, it is not the spatial differences in prices *per se* that should be of concern to the policy makers, but rather excessive variability and, in some cases, *no or little* variability of staple food prices across space. The need for spatial analysis arises because agricultural commodities are bulky and perishable, their production is seasonal, and production and consumption points are spatially dispersed. As a result, the transportation of a commodity from one market to another is costly and requires special efforts (Sexton *et al*, 1991). Spatial price analysis involves the study of spatial markets in which the concept of pricing efficiency is distinguished from the concept of market integration. The pricing efficiency is the price-based notion of equilibrium, whereas the market integration is the flow-based indicator of tradability (Barrett, 2001). According to Ojo (1998), the plausible underlying factors of the price spatiality in Nigeria can be categorized into global, regional and national factors. Therefore, analyzing the channels of pepper distribution and the functioning of the pepper markets is an important issue. Many economically important commodities are costly to transport and the spatial aspects of markets for such commodities cannot be ignored. Spatial patterns of marketing give rise to a complex web of relationships among prices throughout a market.

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Spatial price analysts attempt to study price behavior in order to gain insight into the workings of the market and to test whether it is performing well (Fackler, 1996). The study however, analyzed specifically the factors that influence spatiality in price of pepper in the area; determined the marketing costs and returns of the product marketed at spatial market locations; determined the effect of spatial price on the quantity sold for the agricultural product; and determined the price elasticity's of pepper in the defined market location

Methodology

The study area is Ezza South Local Government Area of Ebonyi State. The area is made up of four (4) major markets to include "Eke-Imoha" market, "Oriegbe" market, "Nkwuda-Ezza" market, and "Nwaffia-Ogu" market, . According to (NPC, 2006), Ezza south has a population of 133,625 people and the total land mass 324 square kilometers. From the four (4) major markets, thirty (30) pepper marketers were randomly selected to give a sample size of one hundred and twenty (120) respondents. Primary data were collected using structured questionnaires. Data collected were analyzed using both descriptive and inferential statistics.

Model Specification:

Factor analysis model;

$Y_i = \alpha_{i0} + \alpha_{i1}F_1 + \alpha_{i2}F_2 + \alpha_{i3}F_3 + \alpha_{i4}F_4 + \alpha_{i5}F_5 + \alpha_{i6}F_6 + \text{-------} + \alpha_{in}F_n + e_i$

Where, α_i = Parameters or Loadings. Thus, $\alpha_1 - \alpha_n$ is the loading of variable Y_i on factors F_n.

Simple regression model;

Y= f(x)…………………..Implicit Form

$Y = a_0 + a_1x_1$…………… Explicit non stochastic

$Y = a_0 + a_1x_1 + et$…….. Explicit stochastic

Where: Y= Quantity sold in Kg x_1 = Spatial prices

α_0 = constant

α_1 = regression coefficient

et = Stochastic error term.

Coefficient of Elasticity;

$Ei = \frac{\%\blacktriangle Q}{\%\blacktriangle P}$, Where: Ei = Coefficient of Elasticity, $\%\blacktriangle Q$ = percentage change in quantity demanded of pepper, $\%\blacktriangle P$ = percentage change in price of pepper

Gross margin model;

Gm = TR – TVC

Profit (π) = Gm – TC

TC = TVC + TFC

Benefit-Cost-Ratio (BCR) = TR/TVC

Where: Gm = Gross margin, TR = total revenue

Result Discussion

From table 1, factor analysis was used to analyze the factors influencing spatial price of pepper in the area. The purpose was to analyze the factors and then interpret variables that load high using Kaiser (1950)'s rule of thumb in which variables with coefficient of ≥0.3 were identified as having strong influence. Result of the analysis shows that infrastructural factors influencing spatial price of pepper are; the cost of transportation, availability of storage facilities. Again, the economic factors that influenced spatial price of pepper are; the number of pepper buyers, market organisation, and individual price fixing. This finding corroborates Girapunthong *et al.* (2003) who posited that market boundaries covered by each trader are generally narrow, as a result of a number of factors contribute to market separation. This can be attributed to the occurrence of temporal and spatial

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frictions resulting from high transport costs, primarily because of poor roads and road networks. Secondly, the inadequate price information about other markets can result to poor information transmission channels, inefficient communication systems and absence of official (government) price communication/media (Nigerian Institute of Social and Economic Research (NISER), 2001). The third factor is the incidence of individualized price formation processes resulting from haggling. This can be attributable to lack of product homogeneity and standardized units of measurement. Finally, the presence of market associations may limit the market access of poor rural farmers who may be discriminated against by the capital rich wholesaler. The majority of farmers and retailers have poor access to credit, which may reduce their ability to respond to price changes.

From table 2, the result of simple regression analysis shows that the coefficient of multiple determination (R^2) was 0.768 which indicates that about 77% in the total variations in dependent variable (quantity of pepper sold) was influenced by the independent variable (spatial price) in the area. The coefficient of spatiality of price was positively related to the quantity of pepper sold in the area, signifying that every one unit increase in spatial price in the price of pepper will bring about an increase in the quantity of pepper sold in the area.

Table 3 shows that price of pepper vary significantly at different markets in Ezza South Local Government Area of Ebonyi State. This was justified as a bag of 50kg of pepper was sold at ₦4800 ₦5000, ₦4800, and ₦5400 in "Eke-Imoha", "Orie-egbe", "Nkwuda Ezza" and "Nwafia-Ogu" Markets. However, despite the spatiality of prices in the markets the coefficients of elasticity in each of the market locations were elastic; thus implying that in every ₦1 increase in the price of pepper will result into a unit increase in the quantity of pepper marketed in the area. This finding was attributed to the fact that farmers are very sensitive to the market forces as they will normally prefer to sell their products at the time when there will be an upward increase in price so as to create incentive for their product.

Profitability measure of pepper as seen in table 3, was determined using gross margin analysis. In each of the spatial markets, 100 bags of 50kg bags of pepper were used as yardstick. From the analysis, it was observed that in "Eke-Imoha", the total variable cost was ₦709,000.00, total fixed cost was ₦14,600 and the profit was ₦956,400.00. A Benefit Cost Ratio (BCR) analysis shows 1: 2.32. Implying that in every ₦1 spent in marketing pepper in the area, a profit of ₦1.32k was realised as return to investment. In "Nkwuda Ezza", the total variable cost was ₦537,000.00, total fixed cost was ₦14,600 and the profit was ₦1,148,400.00. A Benefit Cost Ratio (BCR) analysis shows 1: 3.08. Signifying that in every ₦1 spent in marketing pepper, a profit of ₦2.08 was realised as return to investment. In "Orie-Egbe", the total variable cost was N516,000.00, total fixed cost was ₦14,400 and the profit was ₦1,419,600.00. The cost benefit ratio indicates 1: 3.17. This implies that in every ₦1 spent in marketing pepper in the area, a profit of ₦2.17 was realised as return to investment. In "Nwaffia-Ogu", the total variable cost was ₦506,000.00, total fixed cost ₦13,600 and the profit was ₦1,480,400.00. A Benefit Cost Ratio (BCR) analysis

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shows 1: 3.21. This implies that in every ₦1 spent in marketing pepper in the area, a profit of ₦2.21k was realised as return to investment. Consequent upon the general profitability of pepper marketing in the area, the individual market analysis shows that marketing of pepper is most profitable in "Eke-Imoha". This findings was in-line with that of Fackler, (1996), who maintained that return to investment is a function of rate of turn-over in business enterprises.

Conclusion

The spatiality in the price of pepper has been found to be elastic and positively related to the quantity of pepper marketed in the study area. However, the study recommended the provision of marketing infrastructures such as good roads to enhance easy delivery of pepper to the point of demand. Again, government market agency should provide and enforce the use of a standard unit of measure to enhance uniformity in the price of pepper in the area.

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Table 1: Varimax Related Component Factor on Factors influencing Spatial Price of Pepper marketing in Ezza South Local Government Area

Variables	Factor I Infrastructural Constraints	Factor II Economic Constraints
Transportation	0.775	0.32
Number of Buyers	-0.143	0.799
Market information	0.193	0.193
Storage Facility	0.732	-0.048
Market Organization	-0.181	0.356
Good Policy	-0.110	0.642
Individual Price fixing	0.323	0.690

Source: Field Survey, 2017

Table 2: Simple Regression Results of the effect of Spatial Price on the Quantity of Pepper Sold in Ezza South Local Government Area

Variables	Coefficients	Std Error	t-value
Constant	-11.676	22.166	-0.527
Spatial Price	0.007	0.008	0.900
R^2	0.768		
D.W	1.354		
F-Statistics	0.89		

Source: Computed From Field Data, 2017

Table 3: Price Elasticity of Pepper Marketing in Ezza South Local Government Area

Markets	Priceof Pepper/50kg/Naira	Coefficient of Elasticity	Remark
"Eke-Imoha" Market	4,800	1.25	Elastic
"Orie-egbe" Market	5,000	2.5	Elastic
Nkwuda Ezza Market	4,800	1.43	Elastic
Nwafia-Ogu Market	5,400	1.45	Elastic

Source: Field computation, 2017

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Table 4: Costs and Returns of Pepper Marketing in Ezza South Local Government Area

Variables	"Eke-Imoha"	"Nkwuda-Ezza"	"Orie-Egbe"	"Nwafia-Ogu"
Total variable cost(TVC)	709,000	537,000	516,000	506,000
Total fixed cost(TFC)	14,600	14,600	14,400	13,600
Total Revenue(TR)	1,680,000	1,700,000	1,950,000	2,000,000
Gross margin = TR-TVC	971,000	1,163,000	1,434,000	1494,000
Profit = TR – TFC	956,400	1,148,000	1,419,600	1,480,400
BCR = TR /TVC	1:2.32	1:3.08	1:3.17	1:3.21
Return to investment	1.32	2.08	2.17	2.21

Source: Field survey, 2017

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GERMINATION AND SEEDLING GROWTH OF FLAME OF THE FOREST (*Delonix regia*) AS AFFECTED BY SCARIFICATION METHOD AND DIPPING DURATION

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ABSTRACT
A field experiment was conducted at the Horticultural nursery of Federal University of Technology, Minna to investigate the influence of scarification method and dipping duration on the germination and seedling growth of flame of the forest (Delonix regia). The treatments consisted of two factors (i) Sacrification methods used in breaking dormancy: H_2SO_4 (70%); Gibberellic acid (0.2 g/L); and untreated (control); (ii) Dipping duration of 10, 20 and 30 minutes. The treatments were arranged in a 2 x 4 factorial in a Completely Randomized Design with five replications. Data collected on germination parameters, were subjected to Analysis of Variance and treatment means were separated using Least Significant Difference (LSD) at $P \leq 0.05$. Scarification method had a significant effect on Delonix regia seeds, as seeds treated with H_2SO_4 at 30 minutes dipping had the highest germination percentages (88%) at (9 - 30 Days After Sowing) followed by seeds dipped for 20 minutes (65%) and 10 minutes (50%). Seeds of Delonix regia treated with GA_3 had the highest number of branches per plant at dipping duration of 30 minutes, while seeds treated with GA_3 had the broadest leaf area (268.4 cm^2) at dipping duration of 30 minutes. Seeds treated with GA_3 at 30 minutes dipping had the tallest plant height of (52.0 cm) followed by those dipped for 20 minutes (49.0 cm) and 10 minutes (46.0 cm). Control (untreated) seeds recorded the lowest number of branches (15), with the least plant height of (27.6 cm).
Keywords: *Delonix regia, tetraoxosulphate (vi) acid, Gibberellic acid, Dipping duration.*

INTRODUCTION

Flame of the forest (*Delonix regia*) is a deciduous tropical tree that is considered as one of the most beautiful tree in the world due to its bright orange-yellow bloom. (Rahman*et' al*, 2004). It losses all its leaves during the dry season and begins to sprout immediately as rain commences, however in climate where cold is not much dryer than hot, it is ever green tree (Rahman *et' al,* 2004). The ornamental tree is valued mainly for its shade provision, bloom beauty, wood for agricultural implements and oil processed as insecticidal and anti- bacterial material. The seed when powdered is used to purify and enriches the blood.

Delonix regia is good in controlling soil erosion in the arid and semi- arid areas because of its hardy nature and aggressive root system. It can be planted as live fence posts, grown on eroded sites for erosion control, and for soil rehabilitation and improvement through atmospheric nitrogen fixation. The objectives of this study therefore were to;

- determine the germination of *Delonix regia* using chemical method, GA3 (gibberelic acid), sulphuric acid (H_2S0_4) and control method.
- assess the effect of scarification and dipping duration on the seed
- study the effect of mechanical scarification on seed germination and seedling growth and
- investigate the effect of soaking of seeds in water or concentrations of sulphuric acid on seed germination and seedling growth.

MATERIALS AND METHODS

Experimental location

The experiment was carried out at the experimental nursery of Crop Production department, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna Niger

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State on a latitude 9^0 40'N and longitude 6^0 3'E

Source of seed

Seeds of flame of the forest was collected from fully grown trees at the front of the main campus Federal University of Technology, Minna Niger State.

Seed treatments

The seeds of flame of the forest were treated with tetraoxosulphate (vi) acid, (H_2SO_4) and gibberellic acid (GA_3) at different variation of dipping of 10 minutes, 20 minutes, and 30 minutes, then the seeds were rinsed with distilled water to remove the remains of the acid from the seeds before sowing the seeds in polythene bags of (25x20) cm containing 14 kg of soil at the nursery.

Data collection and Analysis

The treatments were arranged in a Completely Randomized Design (CRD) with five replications in a 3 x 3 factorial experiment resulting in nine treatment combinations. Data were collected on the days to first emergence, days to 50% germination, percentage germination, plant height, number of leave, leaf area, and stem girth. Data collected were subjected to analysis of variance (ANOVA) using SAS package and means were separated using Least Significant Difference (LSD) at 5% level of probability.

RESULTS

Effect of scarification method and dipping on seed germination of *Delonix regia* The result showed that scarification method had a significant ($p \leq 0.5$) effect on germination of *Delonix regia* at 8 and 9 DAS. At 8 and 9 DAS seed of *Delonix regia* treated with H_2SO_4 resulted in the highest germination rate (0.8 and 0.9 respectively) than the other scarification methods. Dipping duration at 30 minutes resulted in the highest germination rate (0.8) compared to the other dipping durations. The interaction between the scarification method and the dipping duration were not significant throughout the study as reported in Table 1.

At 18-30 DAS seed of *Delonix regia* treated with H_2SO_4 produce the highest germination rate (1.4) than the other significations, dipping duration had a significant effect on germination of seed of *Delonix regia,* at 18-30 DAS in the study. During this time dipping duration at 30 minutes at 18 DAS resulted in the highest germination rate compared to the other dipping duration. The interaction between the scarification method and dipping duration were not significant on *Delonix Regia* seed germination in this study.

Effect of scarification method and dipping duration on stem girth of *Delonix regia*

The result of the effect of scarification methods and dipping duration on stem girth of *Delonix regia* with 9-14 WAS shown in Table 3, scarification method had significant ($P<0.05$) effect on stem girth of *Delonix regia* at 9 and 14 WAS respectively, at 14 WAS control produce the highest stem girth (1.8 mm) and dipping duration has a significant effect on stem girth of *Delonix regia* at 14 WAS, the interaction between scarification method and the dipping duration were not significant

Effect of scarification method and dipping duration on number of leaves of *Delonix regia*

The result of the effect of scarification and dipping duration on number of leaves of *Delonix regia* at 9th week to 11th WAS shown in Table 4, scarification method had a significant ($P \leq 0.05$) effect on number of leave of *Delonix regia*, at 9, 10 and 11 WAS. At 11 WAS *Delonix regia* treated with GA_3 resulted in the highest number of leave (1391.2) and (944.8) which was statistically similar to *Delonix regia* treated with GA_3 and untreated (control). At 11th WAS *Delonix regia* treated with GA_3 had the highest number of leave (1391.2) which was similar to *Delonix regia* treated with H_2SO_4 and control. Dipping duration of *Delonix regia* had a significant effect on number of leave of *Delonix regia* during the period of the experiment.

Effect of scarification method and dipping duration on number of branch of *Delonix regia*

The result of the effect of scarification and dipping duration on number of leaves of *Delonix regia* at 9-17 was shown in Table 5, scarification had a significant ($p \leq 0.05$) effect on number of branches of *Delonix regia* at 9-17 WAS respectively, at 17 WAS seed of *Delonix regia* treated with GA_3 resulted in the highest number of branches (21.9) while control at 9th WAS produce the lowest number of branches (6.0). Dipping duration had a significant effect on number of branches of *Delonix regia* at 17WAS seeds that were dipper for 30 minutes resulted in the highest number of branches (21.2) compared to the other dipping duration. The interaction between effect of scarification method and dipping duration were not significant on number of branches of *Delonix regia*

Effect of scarification method and dipping duration on leave area of *Delonix regia*

The result of the effect and dipping duration on leave area of D*elonix regia* at 9-14 WAS is shown in Table 4.4 Scarification method had a significant ($p<0.05$) effect on leave area of *Delonix regia*, at 9-14 WAS at 14 WAS, seed of *Delonix regia* treated with GA_3 had the broadest leaf areas (268.4cm^2) and while the seed of *Delonix regia* treated with H2SO4 at 9 WAS produced the lowest leave area (64.0cm^2). the dipping duration had a significant effect on leave area of D*elonix regia* at 14 WAS in this study dipping duration of 30 produced the highest leave area (264.4cm) compared to other dipping duration, the interaction between effect of scarification method and dipping duration were not significant on leave area.

Effect of scarification method and dipping duration on plant height of *Delonix regia*

The result of the effect of scarification method and dipping duration on plant height of *Delonix regia* at 9-17 WAS is shown in table 4.5, scarification method had a significant ($P<0.05$) effect on plant height of *Delonix regi*a with 9-17 WAS at 17 WAS, seed of *Delonix regia* treated with Gas had the tallest plant height (50.4cm) followed by seeds treated with H_2SO_4, while control recorded the lowest plant height (47.6). Dipping duration had a significant effect on plant height of *Delonix regia* with seed dipped for 30min resulting to tallest plant height of (51.6cm) compared to the dipping duration, the interaction between scarification method and dipping duration were not significant on plant height of *Delonix regia.*

DISCUSSION

The germination of flame of the forest (*Delonix regi*a) was significantly ($p < 0.05$) influenced by Scarification method and dipping duration. The highest germination percentage was observed in combining the use of gibberellic acid, tetraoxosulphate (vi) acid for 30 minutes. This explains why pre-treating the seeds of flame of the forest at a specified dipping duration had been recommended for its quick germination. Chuanren, *et al.,*

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(2004) supported that seeds of flame of the forest are similar to those of many other hard coated legumes and that germination is enhanced if seed coats are softened or scarified.

Germination success of flame of the forest in the nursery, with GA_3 and H_2SO_4 was unique, for 30 minutes duration of dipping. It was observed that seeds treated with GA_3 for 30 minutes performed better than seeds dipped in H_2SO_4, for 10 and 20 minutes. Application of growth regulators such as GA_3 has a positive effect on germination; this was in conjunction with Seiler (1994) who reported that the use of gibberellic acid (GA_3) doubled the germination rate of dormant seeds with hard seed coat (Sunflower, golden shower). Application of exogenous compounds, such as GA or ethylene, will modify the ABA: GA; ratio removing dormancy effects, allowing seeds to germinate. This was confirmed by Borghetti *et al*. (2002), when seeds submerged in ethyl (25 ppSm) had significantly increased germination.

Conclusion

Based on the result from the experiment it could be concluded that, highest germination was recorded in seeds treated with tetraoxosulphate (vi) acid for 30 minutes, accorded by seeds treated with gibberellic acid at 30 minutes duration of dipping, it is therefore concluded that seeds of flame of the forest should be treated with tetraoxosulphate (vi) acid and gibberellic acid for 30 minutes to support maximum and optimum emergence and growth of the seed.

Recommendation

From the result obtained, it is recommended that flame of the forest seed should be treated with gibberellic acid and (GA_3), tetraoxosulphate (vi) acid (H_2SO_4) for 30 minutes, to soften the hard seed coat and thereafter enhance the quick germination.

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Table 1: Effects of scarification method and dipping duration of germination of *Delonix regia*

Field trialTreatment															
Germination (DAS)															
Method	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
H_2SO_4	0.1^{a}	0.1^{a}	0.1^{a}	0.1^{a}	0.2^{a}	0.4^{a}	0.7^{a}	0.7^{a}	0.9^{a}	1.0^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.2^{a}
GA3	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{b}	0.0^{b}	0.3^{a}	0.4^{a}	0.4^{a}	0.7^{a}	0.8^{a}	0.9^{a}	1.1^{a}
Control	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{b}	0.7^{b}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}	0.7^{a}
SE+	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.4	0.4	0.4
Dipping Duration (Minutes)															
10	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{b}	0.2^{a}	0.2^{a}	0.3^{a}	0.5^{a}	0.7^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	1.0^{a}
20	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{a}	0.0^{b}	0.2^{a}	0.3^{a}	0.3^{a}	0.5^{a}	0.7^{a}	0.7^{a}	1.0^{a}	1.0^{a}	1.2^{a}	1.2^{a}
30	0.2^{a}	0.2^{a}	0.2^{a}	0.2^{a}	0.3^{a}	0.3^{a}	0.3^{a}	0.3^{a}	0.8^{a}	0.8^{a}	0.8^{a}	0.8^{a}	1.0^{a}	1.0^{a}	1.3^{a}
SE+	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Interaction															
H*L	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same Alphabet(s) in a column for the same factor are not significantly different at P < 0.05 by LSD NS= Not Significant

Table 2: Effects of scarification method and dipping duration of germination of *Delonix regia*

Treatment															
Germination								(DAS)							
Method	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
H_2SO_4	1.2^{a}	1.2^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}	1.4^{a}
GA3	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}	1.1^{a}
Control	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}
SE+	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Dipping Duration (Minutes)															
10	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}	1.0^{a}
20	1.2^{a}	1.2^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}	1.3^{a}
30	1.3^{a}	1.3^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}
SE+	1.5a	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}	1.5^{a}
Interaction															
H*D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same Alphabet(s) in a column for the same factor are not significantly different at P < 0.05 by LSD (DMRT) NS= Not Significant

Table 3: Effect of scarification method and dipping duration on stem girth of *Delonix regia*

Treatment						
	WEEK AFTER SOWING (WAS) (mm)					
Method	9WAS	10WAS	11WAS	12WAS	13WAS	14WAS
H_2SO_4	0.5^{a}	0.9^{a}	1.1^{a}	1.3^{a}	1.6^{a}	1.8^{a}
GA3	0.6^{a}	0.9^{a}	1.0^{a}	1.3^{a}	1.5^{a}	1.7^{a}
Control	0.4^{a}	0.5^{a}	0.9^{a}	1.1^{a}	1.5^{a}	1.8^{a}
SE+	0.2	0.2	0.2	0.2	0.3	0.3
Dipping Duration (Minute)						
0	0.4^{a}	0.5^{a}	0.9^{a}	1.1^{a}	1.5^{a}	1.8^{a}
10	0.5^{a}	0.8^{a}	1.0^{a}	1.2^{a}	1.4^{a}	1.7^{a}
20	0.5^{a}	0.8^{a}	1.0^{a}	1.2^{a}	1.6^{a}	1.8^{a}
30	0.7^{a}	1.0^{a}	1.2^{a}	1.5^{a}	1.6^{a}	1.8^{a}
SE+	0.2	0.3	0.3	0.3	0.3	0.3
Interaction						
H*D	NS	NS	NS	NS	NS	NS

Means followed by the same Alphabet(s) n a column for the same factor are not significantly different at P < 0.05 by LSD NS= Not Significant

Table 4: Effect of scarification method and dipping duration on number of leave of *Delonix regia*

TREATMENT	NUMBERS OF LEAVES	WEEK AFTER SOWING	
Method	9WAS	10WAS	11WAS
H2SO4	666.7a	944.8a	1276.0a
GA3	538.8a	756.0a	1391.2a
Control	370.3a	508.0a	667.0a
SE-+	133.54	294.49	326.43
Dipping Duration (Minutes)			
10	489.2a	1006.3a	1480.8a
20	560.8a	698.5a	1149.5a
30	758.2a	847.7a	1370.5a
SE+	163.6	360.7	399.8
Interaction			
H*D	Ns	Ns	Ns

Means followed by the same Alphabet(s) n a column for the same factor are not significantly different at P< 0.05 by LSD NS= Not Significant

Table 5: Effect of scarification method and dipping duration on number of branches on *Delonix regia*

TREATMENT		**NUMBER OF BRANCHES**			**WEEKS AFTER SOWING**				
Method	9WAS	10WAS	11WAS	12WAS	13WAS	14WAS	15WAS	16WAS	17WAS
H2SO4	6.4a	7.9a	9.0a	10.8a	12.3a	14.4a	15.6a	16.9a	18.7a
GA3	6.7a	8.7a	9.3a	11.8	13.3a	16.2a	17.4a	19.1a	21.9a
Control	6.0a	7.3a	8.0a	9.0a	10.0a	12.0a	14.3a	18.0a	21.0a
SE+	0.6	0.9	1.0	1.9	1.8	2.1	2.0	2.3	2.2
Dipping Duration (Minute)									
10	6.2a	7.3a	8.5a	12.2a	13.8a	17.5a	18.2a	19.2a	20.7a
20	6.3a	7.8a	8.5a	9.5a	10.7a	13.2a	14.2a	16.0a	19.0a
30	7.2a	9.7a	10.5a	12.2a	14.0a	15.3a	17.2a	18.8a	21.2a
SE+	0.8	1.1	1.2	2.4	2.3	2.6	2.5	2.8	2.7
Interaction H*D	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at P < 0.05 by LSD NS= Not Significant

Table 6: Effect of scarification method and dipping duration on leaf area of *Delonix regia*

TREATMENT	**LEAF AREAWAS**					
METHOD	9WAS	10WAS	11WAS	12WAS	13WAS	14WAS
H_2SO_4	64.02 [a]	101.7	138.7 [a]	166.8 [a]	194.0 [a]	243.0 [a]
GA3	73.5 [a]	95.3 [a]	133.6 [a]	159.4 [a]	190.8 [a]	268.4 [a]
Control	71.6 [a]	90.7 [a]	121.0 [a]	139.3 [a]	164.8 [a]	197.7 [a]
SE+	23.3	28.4	40.0	40.0	39.9	51.6
Dipping Duration (Minute)						
10	96.3 [a]	113.3 [a]	151.2 [a]	182.4 [a]	225.6 [a]	261.5 [a]
20	68.5 [a]	90.3 [a]	114.6 [a]	130.5 [a]	151.3 [a]	241.3 [a]
30	41.5 [a]	92.0 [a]	142.5 [a]	176.4 [a]	200.4 [a]	264.4 [a]
SE+	28.6	34.9	49.1	49.0	48.9	63.2
Interaction						
H*D	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at P < 0.05 by LSD NS= Not Significant

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TABLE 7: Effect of scarification method and dipping duration on plant height on *Delonix regia*

TREATMENT									
	PLANT HEIGHT		WEEKS AFTER SOWING (WAS)						
Method	9WAS	10WAS	11WAS	12WAS	13WAS	14WAS	15WAS	16WAS	17WAS
H_2SO_4	10.6 a	20.8 a	25.5 a	28.9 a	32.9 a	35.7 a	39.5 a	42.8 a	47.6 a
GA3	10.9 a	23.4 a	27.4 a	30.6 a	33.7 a	37.1 a	41.1 a	46.4 a	50.4 a
Control	9.5 a	18.5 a	23.8 a	28.6 a	31.7 a	36.4 a	39.9 a	43.6 a	47.6 a
SE+	1.4	2.2	3.2	3.4	3.8	4.0	4.2	4.4	4.2
Dipping Duration (Minute)									
10	10.0 a	21.1 a	25.4 a	28.7 a	32.1 a	34.7 a	38.4 a	41.4 a	46.1 a
20	12.1 a	22.3 a	25.4 a	28.5 a	31.5 a	35.2 a	39.5 a	45.8 a	49.4 a
30	10.1 a	23.0 a	28.7 a	32.1 a	36.4 a	39.4 a	43.0 a	46.8 a	51.6 a
SE+	1.7	2.6	3.9	4.2	4.6	5.0	5.2	5.3	5.1
Interaction H*D	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in a column for the same factor are not significantly different at $P < 0.05$ by LSD NS= Not Significant

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ECONOMICS ANALYSIS OF MUSHROOM PRODUCTION IN IBADAN, OYO STATE, NIGERIA

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Abstract
The study was carried out to analyse the economics of mushroom production in Ibadan, Nigeria. Data were collected by the use of questionnaire. A total of 22 respondents were sampled from three institutions involved in mushroom production in Ibadan. They are Forestry Research Institute of Nigeria (FRIN), National Horticultural Research Institute of Nigeria (NIHORT) and ZATECH. The results shows that 40.9% of the respondents were between 25 and 30 years of age, 36.4% were below 25 years of age. It was found that, 54.5% of the growers were married and 40.9% were single. The study further revealed that fly and cockroach, inadequate cultivation house, inadequate spawn, hot temperature were the constraints faced by mushroom production in the study area. Other constraints include; inadequate capital, high price of raw materials, fungi infection, and inadequate loan facilities. It was found that the net profit per annum was estimated at ₦732,500.00 showing that mushroom production business is a profitable venture hence an investment into mushroom production can be said to be a worthwhile exercise.
Keywords: *Economic, Analysis, Mushroom. Production, Ibadan*

INTRODUCTION

Chang and Miles (2004) defined mushroom as a macro fungus with a distinctive fruiting body which can be either epigeous or hypogenous and large enough to be seen with the naked eye and can be picked with hand. They lack chlorophyll and consequently cannot use solar energy in manufacturing their food. They have been part of fungal diversity for centuries. Their mode of nutrition is by producing a wide range of enzymes that can break down complex substances after which they are able to absorb the soluble substances so formed.

Mushroom is an important vegetable usually grows in the forest with its nutritive and medicinal value. It can also be cultivated domestically in a small scale by landless people. (Imtiaj and Rahman, 2008).

Mushrooms have long been recognized as food items, delicacy and for their medicinal values. The mineral contents in mushroom are higher than those of meat, fish, eggs, cheese and most vegetables (Patra and Pani, 1995). Mushroom production has a good potential in Nigeria, because there are cheap and available substrates, man – power and ready market. The major substrates for cultivation are lignocellulosic wastes while the minor substrates (additives) are nutritional supplements which are added in small quantities.

Many species of mushrooms in Nigeria are edible, although none appears to be deliberately cultivated for that purpose until recently. The realization of the nutritive therapeutic potentials of mushrooms has awakened interest in this regard and individuals, private companies and government are poised to cash in on this potential revenue earner. In Nigeria, mushroom production in natural forests is under threat as most of the indigenous species of mushrooms are endangered. This is a serious problem because mushrooms occur naturally in narrow ecological niches within the tropical forests. The substrates used in mushroom production are usually by-products from industry, households and agriculture.

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(World Bank, 2004). Mushroom production, which is reported to represent the only economically viable bio-technology process for conversion of waste plant residues from forests and agriculture (Wood and Smith, 1987), fits very well into this category. Mushroom cultivation technology is environmentally-friendly. Recently, it has been revealed that mushroom mycelia can play a significant role in the restoration of damaged environments through *myco-filtration* (Stamets, 2006 ../AppData/Local/Durojaiye/Documents/Mushroom 3.html - CR21).

MATERIALS AND METHOD

The study was carried out in the Ibadan. The study area falls in the rain forest region. With the vegetation made up of trees and other forest products, there is a suitable organic matter from woods and stubbles for the growth of mushrooms, particularly the local varieties such as button mushrooms. The sample size was 22, comprising seven from ZARTECH (7), NIHORT (7) and FRIN (8). The growers were interviewed using a pretested interview schedule that was made up of close and open ended questions. The data obtained were analysed using descriptive statistics, and Gross Margin Analyses.

RESULTS AND DISCUSSION

The socio-economic characteristics of the respondents are captured in table 1. The analysis shows that 90.9% of the respondents having tertiary education, and this indicate that mushroom production may be taken as an 'elites' venture. This is likely to improve the techniques of production, since research information on the enterprise would be more likely adopted. Studies have found a significant relationship between level of education and level of adoption of innovations (Alfred *et al*., 2003; Okunlola *et al*., 1998).

Costs and Returns of Mushroom Production in the Study Area

The average total cost of mushroom production was about estimated at ₦467,500.00 of which total fixed cost was determined at ₦ 55,000.00. This represents about of N 11.76% of the average total cost. The study shows that average profit margin of mushroom production in the study area was ₦732,500.00, meaning that the business of mushroom production is a profitable venture.

Constraints faced by mushroom production in the study area

Mushroom is a new crop in Nigeria and most of the farmers are facing many constraints (Table 3). About 95.45% of the sampled producers expressed that fly and cockroaches destroy mushroom spawn. The main reason is that dark place is required for mushroom production and fly and cockroaches also like that environment and thus they eat mushroom spawn. All the sampled respondents (100%) mentioned that high temperature hinders mushroom production. Also, all the respondents reported virus, fungus and germ problems. All the respondents further expressed that inadequate capital has been their major constraint. In addition, the producers also faced with some constraints such as; high price of raw materials, difficulty in obtaining loan due to long process associated, land scarcity and lack of good mother spawn of mushroom.

CONCLUSION

Despite the several constraints faced in mushroom production in the study area, mushroom production is very profitable as revealed by the results obtained. Total revenue of ₦ was realized. The Benefit Cost Ratio (BCR), Return on Investment (ROI), Gross Ratio (GR) , Operating ratio (OR), Fixed ratio (FR) were all computed at ₦ . ₦ , ₦ , ₦ , respectively and they were all positive. These further affirmed that mushroom production is profitable in the study area and could be considered as one of the fastest employment generation and poverty reduction in the area that will improve the social and economic well-being of the respondents. Over all, mushroom production can be said to be a worthwhile exercise.

RECOMMENDATIONS

Based upon the findings from the study, it is hereby recommended that

• Since a larger percentage of the present producers are highly educated, efforts should be geared towards sensitization and mobilization of the rural farmers on the benefits of mushroom production.
• Change agent should also educate and create awareness of the sources of inputs and marketing opportunities associated with mushroom production.
• The producers and would-be-producers could be formed into cooperatives for the purpose of pooling their resources together so as to be able to afford some infrastructure such as storage facility, since the facility was found to have significant relationship with output
• Micro processing enterprises be facilitated and established by relevant stakeholders such as Government, Non-Governmental Organization, Framers group so as to facilitate the processing of the produce into various product for improved acceptability by all.

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Table 1: Socio-Economic Characteristics of the respondents

Variables	**Frequency**	**Percentage**
Sex:		
Male	15	68.2
Female	7	31.8
Total	**22**	**100**
Marital status		
Single	9	40.9
Married	12	54.5
Widowed	1	4.5
Total	**22**	**100**
Age (years)		
Below 25	8	36.4
25-30	9	40.9
31-35	2	9.1
36-40	3	13.6
Total	22	**100**
Educational background		
No formal education	0	0.0
First school leaving certificate	0	0.0
SSCE	2	9.1
Tertiary education	20	90.9
Total	**22**	**100**

Source: Field survey, 2018

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Table2 : Analysis of costs and returns of mushroom production in the study area

ITEM	PRICE (₦)	Percentage
Bamboos	3,000.00	0.64
Polythene	8,000.00	1.71
Cloth	2,000.00	0.43
Plastic pipes	1,000.00	0.21
Water supply pipes	4,000.00	0.86
Water supply machine	15,000.00	3.21
Woods	5,0000.00	1.07
Jute bag	3,000.00	0.64
Rent	4,000.00	0.86
Land preparation	2,000.00	0.43
Transportation	8,000.00	1.71
Total variable cost	55,000.00	11.76
Spawn Bags	10,000.00	2.14
Permanent Hired labor:		
Male	180,000.00	38.5
Female	180,000.00	38.5
Total fixed cost	370,000.00	79.14
Sub total cost	425,000.00	90.90
Contingency (10%)	42,500	9.10
Total cost	467,500.00	100
Revenue from Mushroom	1,200,000	
Gross margin	830,000.00	
Net profit/annum	732500.00	

Source: Computed from field survey, 2018

Table 3: Production constraints faced by mushroom production

Problems	Frequency	Percentage
Infestation by Fly and cockroach	21	95.45
Inadequate/poor cultivation house	20	90.91
Poor and inadequate availability of spawn	18	81.82
Hot temperatures	22	100
Inadequate capital	22	100
High price of raw materials	18	81.82
Infestation by Virus, fungus and germ	22	100
Long process in obtaining loan	17	77.27
Total	160*	

Source: Field survey, 2018 *Multiple responses

ENHANCING VEGETABLE PRODUCTION THROUGH COMMUNITY PATRTICIPATION IN DASS LOCAL GOVERNMENT AREA OF BAUCH STATE, NIGERIA.

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Abstract
The study was conducted to determine the level of community participation in enhancing vegetable production in Dass Local Govt Area of Bauchi State, Nigeria. The population of the study consisted of 350 vegetable farmers distributed across the four wards of the Local Government Area, which were: Durr, Wandi, Dot and Bununu East. While the sample population was obtained by random selection of 25 farmers from each of the four wards in the area, thus giving a total sample of 100. Structural questionnaires were used to obtain information from the respondents. Percentages and mean were used to analyse the data collected. The results of the study showed that majority of the farmers were male (10%) as against the 2.8% who were female, mostly youths were between 20 – 35 years, over 3.9% had education above primary school as much as 5.4% of the farmers have been engaged in vegetable farming for over five years. However, findings from the study also revealed that the community has been participating in the production of vegetables but not above other crops and are hampered by constraints such as inadequacy of farm inputs, poor soil fertility, land tenure, pest/diseases, marketing, inadequate extension services and financial support. The study therefore recommended that extension services be intensified in the area, while policy interventions including measures of obtaining loans are made easy to the farmers for increased participation and production of vegetables.
Key Words: Vegetables, Community, Production, Constraints.

INTRODUCTION

Vegetable simply defines as ‘’crops usually grown for culinary purposes’’ (Rimando, 20040. He gave examples of vegetable crops under the following classifications: Leafy vegetables, Cole crop or crucifers, Root and bulb crops, Legumes or pulses, Solanaceous vegetables and Cucurbits. It is to be noted that these are a mixture of types of vegetables based on plant parts that are edible and on botanical family; apparently these are mere examples of vegetable grouping. Those plants with immature succulent roots, bulbs, stem, blossoms, leaves, seed or fruit that are eaten (Musa, 2014). Leafy vegetables are eaten for their leafy parts e.g. spinach (*Amaranthus, caudatus*), lettuce (*Lactica sativus*), cabbage (*Brassica olearacea varity capitata*), rossel (*Hibiscus sabdariffa L.*) etc, and they belong to different families (Musa, 2013). Fruit vegetables are group of plant that produce edible fruits example tomato (*Lycopersicom lycopersicom*), garden egg (*Solanum melongena*) and okra (*Abelmoscus esculentus* L. Moench) among others. Presently various communities are actively involved in the production and consumption of vegetables. In Nigeria, vegetable growing is one of the major enterprises of agriculture and is becoming increasingly popular owing to a greater appreciation of their food value. Vegetables, in no small measures, offer people with limited access to meat and fish, rich sources protein and some vital micro nutrients needed for healthy living (Ajewole and Folayun, 2008). Vegetables are not only important as protective food and highly beneficial for the maintenance of health and prevention of diseases, but they are also a source of livelihood for small holder farmers (Oguniyi and Oladejo, 2011). However vegetable are the best source for overcoming micro-nutrient deficiency and provide small holder farmers with much higher income and

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more jobs per hectare than staple crops (AVRDC, 2008).

World health organization (2004) reported that majority of Nigerians live below poverty line with house hold earning less than 400 naira per day. Household food security has been defined as house hold ability to acquire adequate food for its members in terms of quantity, quality, cultural acceptability, and when it is not in an undue risk of losing such access (Okigbo and John, 1998). Food insecurity on the other way round is the lack of access to enough food. Participation of community in vegetable production assist to eradicate frustration and depressed individual from becoming vulnerable to be used to stir up violence, atrocities, unrest and other forms of terrorism which are becoming order of the day in the country (Danjuma and Ibrahim, 2016).

There are some trees that provide shade and their leaves are used as vegetables for human consumption are: Linden (Tilia spp), Horse radish or miracle tree (*Moringa oleifera*) and Boabab (*Adansonia digitata*) among others (Musa, 2014). These vegetables are highly respected suppliers of edible leaves and they generally provide fresh green leaves serving the dry season when most other source of green vegetables is limited (Musa, 2014).

There are various numbers of plants, both wild and domesticated in Nigeria of which the leaves can be consumed either fresh or cooked, information available on the production and value of these vegetable is very scarce, although vegetables are grown in significant quantities, but little or no statistical data are provided for levels of production. For the past few years, most of these vegetables have been cultivated for home consumption and market around the back yard. This is the actual reality for the leafy ones which are mainly ephemeral that grow rapidly and can be harvested within a short period of time. Apart from these, a reasonable percentage of vegetable are still gathered in the wild. The varieties of vegetables that bound in Nigeria are diverse and range from leaves of annual, biennial, perennial shrubs and trees. Study revealed that annual, biennial and perennial shrubs constitute the bulk of vegetables consumed in Nigeria (Pattamaik and Haruna, 1994).

Failure of the community to participate in the production of vegetables would lead to food insecurity, starvation, mal nutrition and all sort of social crisis (Stuart and John, 1995). Vegetable foods have direct bearing to human health and development when vegetables are not given proper priority, human development will be at risk. This failure may surely affect the level of income of the community and a total decline in the standard of living. Another classical example is that if vegetable are under supplied the teaming population will suffer from nutritional imbalance due to lack of vitamin and minerals in their food (Schippers, 2000).

It is therefore significant that the study will examine the demographic characteristics of the community and their level of participation in improving the production of vegetables in Dass local government area of Bauchi state, Nigeria.

METHODOLOGY

Study Area

The study was conducted in Dass local government area of Bauchi state, Nigeria. Dass is located between latitude 10^0E, 21^0N and longitude 9^0N, 47^0E and 609,5m above sea level. It is located in the Northern guinea savannah ecological zone of Nigeria. The raining season in the area last from (April to October) with an annual rainfall of about 1400mm. The highest hill in the study area is Mbula which reach

between 700m-744m. The average minimum temperature is about 11^0c while maximum temperature is 32^0c (Bala and Damina, 2009).
The design used for the research was descriptive survey such as frequency and percentages were used to interpret the data. However, the population of the study consisted of three hundred and fifty (350) vegetable farmers distributed across the four wards of the Local Government Area, which were: Durr, Wandi, Dot and Bununu East. While the sample of the study was obtained by random selection of twenty five farmers from each of the four wards in the area, thus giving a total sample of one hundred.

INSTRUMENTS FOR DATA COLLECTION

The instrument used for data collection for this study is a structural questionnaires, four likert bipolar scale format was designed to answer the research questions.
What is the position of community participation in vegetable production?
What are the demographic characteristics of the respondents?
The data were analyzed using descriptive statistics such as means, percentages and level of community participation and constraint of each of the items under the variable were measured using a 4-point rating scale of Strongly Agree [SA]=4; Agree[A]=3; Disagree[D]=2; and Strongly Disagree[SD]=1; base on the 4-point scale, a mid-point of 2.50 was established thus; 4+3+2+1=4. Decision rule was therefore made that any mean score ≥ 2.50 suggest an extent of community participation or constraints, while any mean score < 2.50 suggest otherwise.

RESULTS AND DISCUSSION

Table 1 showed that 10% of the respondents were male, while 2.8% female. This implies that men are more actively engaged in vegetable production than female. This observation is in line with the findings of (Daniel, 2010) who opined that labour can be divided and used for different farm operations depending on age and sex even though the nature of the task to be performed by the two sexes may differ.

The result however, agrees with the findings of Njoku, (2004) in his study of women labour in household management and vegetable production in rural communities in Jigawa state. He lamented that farm activities and household routine task competes for women participation in vegetable production activities in the area compared with men. Men work more hours per day (12hrs on average bases) to discharge their duties effectively to be able to meet the challenging and participation in vegetable production demands.

Results revealed that 1.7% of the respondents are old above 40 years while 4.1% are young below 40 years. This age structure implies that participation in vegetable production would likely be optimum because the correct age groups were involved in the production.The study indicated that 4.2% of the respondents are married, while 3.8% are single and 1.1% is divorced and 0.5% is widowed respectively. This is in line with the findings of Quayyum,(2009) and Nathalia, (2010) who opined that majority of the farmers are married and would try to raise large family that could assist them coup with labour required in vegetable production. The study also showed that 1.3% completed primary education, while 5.4% completed junior and secondary school education respectively, while 3.6% had attended tertiary education. The study further indicated that 5.3% of the

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vegetable farmers have small family size of between 5-10, while 1.4% of the vegetable farmers have family size of between 11-12 and only 1% of vegetable farmers have family size > 20. This result revealed that labour supply to vegetable production through family labour is low; these lead farmers to hire labour which would further increase the cost of vegetable productions.

This support the opinion of Shehu and Musa, (2011) that family participation rate was low in their study of vegetable harvesting in Kadawa River Basin Agricultural Scheme ((KRBAS). However this also is in line with the finding of (Thomas, 2013) in his study of groundnut harvesting showed that family labour is affordable compared to hire labour outside the family line, he reported that 76% of his respondents in the survey indicated their acceptance.

The study also lamented that majority of the vegetable farmers (3.3%) have less years of experience in vegetable production, 1-15 years compared to 2.6% who have 16 years of experience and above in vegetable production. This indicated that majority of the farmers have < 16 years of experience in vegetable production, this may affect the level of achievement and participation of the production. This further indicated that 4.6% of the respondents cultivated 1-3 hectares of farm land, while 2.3% cultivate 4-5 hectares respectively. This implies that respondents cultivate small large farm size in rural setting; this may be due to low cost and high available land. The study under occupation showed that 5% of the respondents are farmers while 2% are Civil servant/farming while traders 1.8% and others 3.2% respectively.

This also showed that majority of the respondents 5.8% depend solely on personal saving to initiate vegetable production, only 1% sources capital from commercial banks, co-operative societies only 0.8% while 3.1% depend on other source of capital. This may be due to the fact that farmers do not have proper access to source of capital. This is in agreement with the observation of (Balarabe, 2000) that farmers rely only on personal saving due to lack of availability of loan facilities and unpopularity of other sources of capital for initial investment. Table 2 showed the level of community participation in vegetable production. This also stated that out of all the ten (10) statements indicted in respect of community participation in vegetable production 1-6 were agreed on. This lamented that the production activities of vegetable in the area adds to the general vegetable production in the local government, state and at large to assist farmer's income and improve their standard of living. However, statements 8, 9 and 10 disagreed upon which related mainly to the community production of onion for household consumption and the community producing vegetable more than any other crop respectively. This indicated that community produces onion in large scale and is only consumed at household level but also served for commercial purposes, the respondents deeply involved in other kind of occupation observation 9% respectively. Were used to obtain information from the respondents, Percentage for women participation and mean were used to analyse the data collected. The results of the study showed that majority of the farmers were male (10%) as against the (2.8%) who were female, mostly youths were between 20-35 years, over (3.9%) had education above primary school as much as (5.4%) of the

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farmers have been engaged in vegetable farming for over five years. However, findings from the study also revealed that the community has been participating in the production of vegetables but not above other crops and are hampered by constraints such as inadequacy of farm inputs, poor soil fertility, land tenure, pest/diseases, marketing, inadequate extension services be intensified in the area, while policy interventions including measures of obtaining loans are made easy to the farmers for increased participation and production of vegetables.

Table 3; Indicated that responses in constrains to community participation in vegetable production. The researchers revealed that all the ten statements in respect to the constraints of the community participations in vegetable production were accepted by the respondents and number 9-10 disagreed with the statement. This indicated that the identified constrains reduced the participation of the community in vegetable production. This also agreed that the remedy to the identified constraints will dependently increase community participation in vegetable production such will also assist in alleviation of poverty to individuals and also brings about community development in the area.

CONCLUSION

The major findings of this study revealed that the community has been participating in production of vegetables but not above other crops and that they are faced with a lot of constraints, such as inadequacy of farm inputs, poor soil fertility, land tenure, pest/diseases, marketing, inadequate extension services be intensified in the area, while policy interventions including measures of obtaining loans are made easy to the farmers for increased participation and production of vegetables.

RECOMMENDATIONS

Based on the findings of this study the following recommendations were made:

i. Government should encourage researchers that would be farmers specific for awareness to be created on how to improve the quality of land management practices currently in practice.
ii. There is need for the Government to add to the present subsidy style (credit support) providing subsidizing planting material and Agro- Chemical as well as provision of soft loan with price support policy where farmers output at peak period is brought at Farley reasonable price above the current market prices.
iii. Effective extension services should be seriously pursued by Government at all levels to ensure that farmers are educated on vegetable production and utilization practices.

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Table1: Demographic characteristic features of the respondent

Character	Frequency	Percentage%
Gender		
Male	78	10
Female	22	2.8
Age		
10-20	11	1.4
21-30	32	4.1
31-40	31	3.9
41-50	13	1.7
Above 50	6	0.8
Marital Status		
Married	33	4.2
Single	30	3.8
Divorce	8	1.0
Widow	4	0.5
Level of Education Attained		
Primary School	10	1.3
Junior Secondary School	8	1.0
Senior Secondary School	42	5.4
Tertiary Institution	28	3.6
Family Size		
01-05	34	4.4
06-10	41	5.3
11-15	13	1.7
16-20	11	1.4
Above 20	8	1
Years of Farming Experience		
01-05	18	2.3
06-10	26	3.3
11-15	20	2.6
16-20	12	1.5
Above 20	10	1.3
Farm Size (ha)		
1-3	36	4.6
3-5	18	2.3
<5	10	1.3
Occupation		
Farming	39	5
Civil servant/Farming	16	2
Traders	14	1.8
Others	25	3.2
Source of initial capital		
Commercial Bank	8	1
Cooperative Bank	6	0.8
Personal saving	45	5.8
Others	24	3.1

Source: Field survey data, 2015

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Table 2: Responses on the level of community participation in vegetable production

S/N	Items	SA	A	D	SD	N	X	Decision
1	The Community participates in the production	36	22	26	16	100	25	Agreed
2	The Community produces onion	14	35	38	13	100	25	Agreed
3	The community produces spinach in large quantity	16	30	28	27	100	25	Agreed
4	The Community produces tomato in high quantity	23	13	50	14	100	25	Agreed
5	The Community produces garden egg in large quantity	20	26	40	14	100	25	Agreed
6	The Community produces rossel in high quantity	21	38	19	22	100	25	Agreed
7	The Community produces pepper in small quantity	20	23	38	19	100	25	Agreed
8	The Community produces okro in large quantity	26	32	26	16	100	25	Disagreed
9	The Community produces sesame in high quantity for household consumption	18	14	43	25	100	25	Disagreed
10	The Community produces cabbage in high quantity for household consumption	43	26	17	14	100	25	Disagreed

Source: Field survey data, 2015: SA = Strongly Agreed, A = Agreed, D = Disagreed, SD = Strongly Disagreed, N = Number of Farmers, X = Means

Table 3: Response on the constraint to community participation in vegetable

S/N	Items	SA	A	D	SD	N	X	Decision
1	Low soil fertility discourages Community participation from vegetable production	53	33	9	5	100	25	Agreed
2	Problem of land tenure system affect the participation of Community in vegetable product	34	55	10	1	100	25	Agreed
3	Problem of finance is a major constrain to vegetable production	62	28	6	2	100	25	Agreed
4	Problem of pest and diseases discourage vegetable production in the Community	36	51	8	5	100	25	Agreed
5	Problem of poor extension service slows dawn participation in vegetable production	21	51	25	3	100	25	Agreed
6	Problem of low pricing/unorganized market affect vegetable production in my area	19	41	24	16	100	25	Agreed
7	Poor quantity and quality produce due to climate change discourage our participation in vegetable production	36	45	8	11	100	25	Agreed
8	Problem of domestic animals discourage our participation in vegetable production	41	38	16	5	100	25	Disagreed
9	Lack of seed/seedlings affect our participation in vegetable production	16	51	23	10	100	25	Disagreed

Source: Field survey data, 2015: SA = Strongly Agreed, A = Agreed, D = Disagreed, SD = Strongly Disagreed, N = Number of Farmers, X = Means