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.

REFERENCES

Ali, S., Mohammed, W., Shimelis, B. (2015) Agronomic and Physicochemical Evaluation of Sweet Potato *Ipomoea Batatas* (L.) Lam. Collections in Ethiopia. *Adv Crop Sci Tech*, 3: 172.

Bechoff, A., Malinga, J., Njoku, J., S., Njoku, A., Abidin, E., Mbabu, A. (2013). In: Everything You Ever Wanted to Know about Sweet potato: Reaching Agents of Change ToT Manual. International Potato Center, Nairobi, Kenya.p39

Black, C.A. ed (1965): Method of Soil Analysis ,American Society Agronomy, Madison, Wisconsin. (Agronomy No 9).

Brandenberger L., Shrefler J., Eric, R and Damicone. (2010). Sweet Potato Production Oklahoma Cooperative Extension Services HLA- 6022. Oklahoma Cooperative Extension Fact Sheets. Division of Agricultural Sciences and Natural Resources. Oklahoma State University.

CIP. International Potato Center, (1999). Sweet Potato Fact and Figures. cipotato.org/sweetpotato/fact/.

Gasura, E., Mashingaidze, A.B and Mulasa, S.B. (2008). Genetic Variability for Tuber Yield Quality and Virus Complex Traits in Uganda Gymplasm. *African Crop Science Journal*, 26(2): 147-160.

George, M.S., Lu, G. and Zhou (2002). Genotypic Variation for Potassium Uptake and Utilization Efficiency in Sweet Potato. *Field Crop Research*, 77: 7-12.

Huaman Z., Aguilar C. and Ortiz, R. (1999) Selecting a Peruvian Sweet Potato Core Collection on Basis of Morphological, Co-Geographical, and Disease and Pest Reaction Data. *Theoretical and Applied Genetics,* 98: 840-845

Isiaka, K. (2013). Fertilizer Treatment Effects on Yield and Quality Parameters of Sweet Potato (*Ipomoea batatas*). *Res. J. Chem. Env. Sci.*, 1(3): 40-49.

Kokorom, S. A. and Molo, R. And Ogwanga, J. (1992, November). Evaluation of sweet potato clones for resistance to weevils. In: Proceeding of 5th symposium of ISTRCAB held at Kampala Uganda

Leigh, A. (2012). Sweet Potato Value Chain: Nigeria. Evans Policy Analysis and Research Brief No 220. Evans School of Public Affairs, University of Washington.

Levette, M.P. (1993). The Effect of Methods of Plant Cuttings of Sweet Potato (Ipomoea batatas (L.)Lam) on Yield. *Tropical Agric. Trinidad*, 70(2): 110- 115.

Mesenbet, Melkam (2015). Genetic

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Variability and Association of Traits in Sweet Potato (*Ipomoea batatas* (L.) Lam) Genotypes at Haramaya, Eastern Ethiopia. A Thesis Submitted to the Postgraduate Program Directorate (School of Plant Sciences) Haremaya University. In Partial Fulfillment of the Requirements for the Degree of Master of Science in Agriculture (Horticulture).

Ngailo, S, Shimelis H, Sibiya S, Mtunda K (2013). Sweet Potato Breeding for Resistance to Sweet Potato Virus Disease and Improved Yield: Progress and Challenges. 8 (25): 3202-3215.

Ssebuliba, J.M., Muyonga J.M. and Ekere, W.(2006). Performance and Acceptability of Orange-Fleshed Sweet Potato Cultivars in Eastern Uganda. *Afr. Crop Sci. J.*, 14(3):231-240.

Stathers, T., Low, J., Mwanga, R., Carey, T., David, S., Gibson, R., Namanda, S., McEwan, M.

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

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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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