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). ptance 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

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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

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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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