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Growth, Fruit Characteristics and Seed Yield of Tomato (*Lycopersicon esculentum* Mill) in Response to Fertilizer Application

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ABSTRACT

Background: Tomato (*Lycopersicon esculentum* Mill) is a staple fruit vegetable, one of the most important vegetables worldwide. There is high demand for tomato planting materials (seeds) in Nigeria.

Methods: Experiment was conducted at the Directorate of University Farms, Federal University of Agriculture, Abeokuta (FUNAAB), Nigeria (7°, 25′N, 3°25′E, 100 m above sea level) to examine growth, fruit characteristics as well as seed yield of tomato (*Lycopersicon esculentum* Mill), cultivar Roma VF in response to fertilizer treatments. Fertilizer types used were, NPK 15:15:15 (300 kg/ha), Poultry manure (10 t/ha), combination of NPK 15:15:15 (150 kg/ha) + Poultry manure (5 t/ha) and a control. Treatments were laid out in randomized complete block design with three replicates. Data were taken on number of leaves, plant height, leaf area, number of branches, number of flowers, number of fruits, fruit length, fruit width, fruit yield, unit fruit weight, number and weight of seeds per fruit. Fruit characteristics were correlated with seed yield to determine the relationship between them. Data were subjected to analysis of variance (ANOVA) and means were separated with least significant difference (LSD 0.05).

Result: Tomato fruits from plots that received a combination of NPK 15:15:15 (150 kg/ha) and Poultry manure had higher fruit yield (5 t/ha) and by inference higher number of seeds, compared with the control. Correlation of fruit weight with number of seeds showed that the higher the fruit weight, the higher the number of seeds per fruit. Fruit length had positive correlation with plant height and fruit diameter. Number of leaves determines fruit weight which invariably determines number and weight of seeds. High number of leaves resulted in low seed weight.

Key words: Fruit length, Fruit weight, Poultry manure, Roma VF, Yield.

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is one of the most widely cultivated and important vegetable crops in Nigeria and in the world as a whole. The Portuguese introduced tomato into the West African sub-region between the 16th and 17th century (Osei *et al*., 2013). It is one of the most common and core world vegetables and ranked second globally to potato (FAO, 2011; Naan Dan Jain, 2012; Godia, 2014). Tomato yield attributes, fruit size (length and width) per plant and pericarp thickness have been reported to correlate positively (Binod *et al.,* 2012). Since the introduction of the crop in Nigeria, farmers have made local selections resulting in the production of several land races (Osei *et al*., 2013). Storage of physiologically matured tomato seeds at freezing temperature is necessary to reduce seed ageing and to maintain high seed quality Rashied *et al.,* (2021). Vaselina and Nikolai (2021) reported that all tested biochemical parameters defining tomato fruit quality (except for acidity) were significantly affected by split potassium fertilization treatments. Fertilizer application improves growth and yield of crops but little attention has been given to the influence of fertilizer on tomato fruit characteristics and seed yield. According to Vasileva *et al*., (2022) tomato yield were significantly affected by cultivars and split potassium fertilization treatments, Amira (2021) recommend using magnetized water irrigation with humic acid addition at concentration of 3.g L^{-1} or 2.g L^{-1} to enhance the productivity and quality of the tomato plant. Therefore, the objective of the work was to determine the effects of fertilizer types on tomato plant growth, fruit and seed yield and to determine the relationship of some growth parameters with fruit characteristics and seed yield of tomato.

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MATERIALS AND METHODS

The experiment was carried out at the Federal University of Agriculture, Abeokuta, Nigeria (7°,25′N 3°25′E, 100 m above sea level), a derived savanna in the year 2019. Pre-planting routine analyses were carried out on both the experimental land soil sample and the poultry manure. The experimental materials were; Tomato (variety Roma VF) and three fertilizer types namely: N. P. K 15:15:15 (300 kg/ha), Poultry manure (10 t/ha), N. P. K 15:15:15 (150 kg/ha) + Poultry manure (5 t/ha) and Control (No fertilizer).

Tomato seeds were sown and maintained on a ground nursery. The experimental treatments were laid out in a randomized complete block design (RCBD) with three replicates. Poultry manure was pre-applied at the rate of 10 t/ha two weeks before transplanting (Tirkey *et al.,* 2002) while N. P. K 15:15:15 was applied at 2 weeks after transplanting (WAT) at 300 kg/ha (Bodunde and Adeniji 2007). Tomato seedlings were transplanted at four weeks old and spaced 50 cm × 50 cm on plot size of 3 m × 4 m. Two seedlings were transplanted per stand and later thinned to one after establishment at two weeks after transplanting.

Data collection

data colletion started 2 WAT on the following parameters using five randomly selected plants per plot: plant height (cm), number of leaves, number of branches, leaf area (cm^2), estimated at 4 and 8 WAT following bodunde and Olarewaju (2003). Number of flowers, number of fruits, fruit length (cm), fruit breadth, fruit diameter (cm). Fruit weight/plant (g), unit fruit weight (g), seed weight/plant (g), stand count per plot was taken at the commencement of harvest to aid in estimating the yield per plant.

Dara analysis

Data collected were subjected to analysis of variance (ANOVA) and significant means were separated using least Significant difference (LSD) at 5% level of probability. Correlation analysis was done to determine the relationship between growth, fruit characteristics and seed yield.

RESULTS AND DISCUSSION

Nutrient composition of soil and poultry manure

The soil used for the experiment was sandy loam and neutral (pH 6.9). The Nitrogen, Phosphorus and Potassium contents were 0.48%, 5.84 ppm and 1.48 ppm, respectively. The organic matter content was 2.45%. The poultry manure was alkaline (pH 8.1) and contained 2.57% Nitrogen while, organic matter content was 5.40% (Table 1).

Effects of fertilizers on tomato vegetative growth

Fertilizer types had no significant ($p \leq 0.05$) effect on the height of tomato plant. However, plants that received poultry manure were taller than plants in other fertilizer treatments (Fig 1).

Similarly, the effect of fertilizer types on number of leaves of tomato was not significant. Although, tomato plants that received NPK 15-15-15 fertilizer had higher number of leaves at 7 Weeks after Transplanting (WAT). There was a general reduction in number of leaves at 8 WAT (Table 2).

The number of branches on tomato plant was significantly affected by the fertilizer type. More branches were observed on plants that received poultry manure only, followed by plants on plots treated with either NPK 15-15-15 or poultry manure + NPK 15-15-15, while plants on control plots had the least number of branches at 8 WAT (Table 3).

There was significant difference ($p \leq 0.05$) in the leaf area of tomato as affected by fertilizer types at 8 WAT (Table 4). Tomato plants from the control plots had wider leaf area at 8 WAT while the least leaf area was observed on plant treated, with poultry manure + NPK 15-15-15.

Effects of fertilizers on tomato fruit production

Tomato plants that received the combination of poultry manure and N. P. K 15:15:15 produced significantly higher number of fruits at 8 WAT compared to those of the control plots which had the lowest number of fruits per plant (Table 5).

Generally, there were no significant differences in fruit diameter, unit fruit weight, number of seeds per fruit and seed weight of tomato in response to fertilizer type. However, fertilizer types resulted in significant differences with respect to the fruit length (Table 6). Longer and wider fruits were recorded in plants that received the combination of poultry manure and N. P. K 15:15:15. Higher fruit weight was recorded in plants from plots that received NPK 15:15:15 while plants from plots that received poultry manure had higher seed weight which though was not significantly different. There was no significant difference in the weight of fruits from all the fertilizer type (Table 6).

Relationship between growth, fruit and seed characteristics of tomato

Number of seeds was positively correlated with weight of seed (r= 0.847) and fruit weight (r= 0.797). Weight of

Table 1: Pre cropping nutrient analysis of soil and poultry manure.

Elements	Soil	Poultry manure
pH	6.89	8.06
N (%)	0.48	2.57
OM (%)	2.45	5.40
P (ppm)	5.84	15.2
Ca (mg/kg)	2.82	21.1
Mg (mg/kg)	1.24	2.90
K (ppm)	1.48	17.7
Na (mg/kg)	0.45	6.90
Cu (mg/kg)	0.34	2.53
Zn (mg/kg)	1.70	2.50
Mn (mg/kg)	6.10	27.80
% Sand	91.91	-
% Silt	5.29	-
% Clay	2.81	-
Textural class	Sandy loam	-

seed was positively correlated with fruit weight (r= 0.713) but negatively correlated with number of leaves (r= -0.590) (Table 7).

The non-significant growth response of tomato across fertilizer treatments as obtained in this experiment could be as a result of adequate native nutrients in the soil of the experimental sites prior to the commencement of the experiment. The superior growth performance of plants that received poultry manure could be as a result of the synergistic action of available micro nutrients present which contradicts Adaramoye *et al.* (2022) who reported that application of NPK 15:15:15 enhances both growth and yield of tomato.

The longer fruit length, wider fruit diameter and higher seed weight obtained in plants from plots that received the application of poultry manure although not significantly different from other fertilizers, could be as a result of the possible availability of micro nutrient in the poultry manure. This was in line with findings of Ayodele (1993) who reported that supplication of micro nutrient increased production by up to 50%. This also agrees with Sobulo *et al.* (1975) and Adaramoye *et al.* (2022) who both stated that adequate nitrogen is required for the growth and yield of tomato.

The positive relationship between seed weight, number of seeds and fruit weight, as obtained in this study, indicated that heavier fruits are likely to produce more seeds with higher weight. This could be as a result of an expectation that fruits from properly nourished plants will have more seeds in their fruits. These agree with Bodunde (2002) who reported that fruit width and fruit length

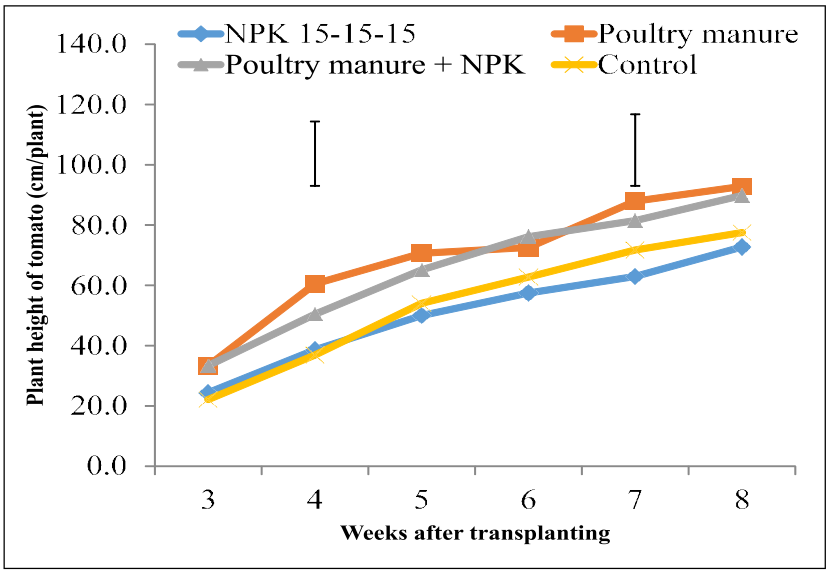


Fig 1: Effect of fertilizer types on plant height (cm) of tomato.

Table 2: Effect of fertilizer types on number of leaves of tomato at 3 to 8 WAT.

Fertilizer type	Weeks after transplanting					
	3	4	5	6	7	8
NPK 15-15-15	7	9	10	13	21	12
Poultry manure	11	11	11	14	17	13
Poultry manure + NPK 15-15-15	10	11	10	18	20	14
Control	8	10	10	17	18	14
LSD (0.05)	3.5	NS	NS	NS	NS	NS

Table 3: Effect of fertilizer types on number of branches of tomato at 3 to 8 WAT.

Fertilizer type	Weeks after transplanting					
	3	4	5	6	7	8
NPK 15-15-15	2	3	3	3	4	6
Poultry manure	4	6	5	5	6	7
Poultry manure + NPK 15-15-15	2	4	5	6	6	6
Control	1	2	4	3	4	4
LSD (0.05)	2.2	3.4	1.9	2.7	3.1	4.0

Table 4: Effect of fertilizer types on leaf area (cm^2) of tomato at 4 and 8 WAT.

Fertilizer type	Weeks after transplanting	
	4	8
NPK 15-15-15	193.64	279.11
Poultry manure	212.63	284.82
Poultry manure + NPK 15-15-15	333.58	254.16
Control	358.13	305.63
LSD (0.05)	NS	28.401*

Table 5: Effect of fertilizer type on number of fruits per plant of tomato at 4 to 8 WAT.

Fertilizer type	Weeks after transplanting				
	4	5	6	7	8
NPK 15-15-15	2	2	4	5	12
Poultry manure	4	6	11	11	17
Poultry manure + NPK 15-15-15	2	7	9	11	23
Control	1	2	7	6	10
LSD (0.05)	NS	NS	11.4	7.2	10.4*

Table 6: Effects of fertilizer types on fruit characteristics and seed yield per fruit of tomato.

Fertilizer type	Fruit length (cm)	Fruit diameter (cm)	Unit fruit weight (g)	Number of seeds /fruit	Seed weight (g)
NPK 15-15-15	1.7	2.4	11.4	78.0	0.7
Poultry manure	1.7	2.3	12.3	81.0	0.8
Poultry manure + NPK 15-15-15	1.9	2.7	13.1	63.0	0.6
Control	1.6	2.2	8.0	69.0	0.7
LSD (0.05)	0.30	0.40	NS	NS	NS

Table 7: Correlation coefficient values of fruit characteristics and seed yield in tomato.

	Weight of seed (g)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Plant height (cm)	Number of leaves	Number of branches	Leaf area (cm^2)
Number of seeds	0.847**	0.797**	-0.091	-0.056	-0.070	-0.410	-0.133	0.000
Weight of seed (g)		0.713*	0.152	0.035	0.145	-0.590*	0.148	-0.349
Fruit weight (g)			0.189	0.329	-0.014	-0.168	-0.112	-0.056
Fruit length (cm)				0.818**	0.685*	-0.193	0.231	-0.357
fruit diameter (cm)					0.462	-0.189	0.203	-0.259
Plant height (cm)						-0.263	0.315	0.070
Number of leaves							-0.035	0.515
Number of branches								-0.196

in tomato are directly responsible for the determination of fruit yield in tomato.

The negative relationship between seed weight and number of leaves could be as a result of diversion of nutrient and assimilates that are supposed to be used in fruits development toward vegetative growth. This is also in line with the assertion that fertilizer rich in N promotes vegetative growth rather than fruit development (Sobulo *et al.,* 1975 and Adaramoye *et al.*, 2022).

CONCLUSION

The impact of poultry manure on growth attributes of tomato, especially the plant height as it influences number of flowers per plant invariably determines the number and weight of fruits, both of which would influence the seed yield, especially the number of seeds. This is reflected in the results of this study. The negative influence of the number of leaves on tomato seed weight as observed in the study suggests that cultural practices that may favour high vegetative structures would not necessarily be the best for seed production.

With this study it is concluded that number of branches on tomato plant is increased by application of poultry manure while the number of fruits and fruit size will be increased by combination of poultry manure and NPK 15:15:15. However, irrespective of fertilizers used although

seed yield was be directly affected but rather influenced by fertilizer effect on fruit size, it may imply that seed yield is a function of the genetic makeup of the variety.

Conflict of interest

All authors declare that they have no conflict of interest.

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