GROWTH AND YIELD INDICES OF TOMATO (*LYCOPERSICON ESCULENTUM* MILL.) AS INFLUENCED BY FIVE DIFFERENT RATES OF POULTRY MANURE

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Abstract

Field experiments were conducted in 2012 and 2013 cropping seasons in the Teaching and Research Farm of Delta State University, Asaba Campus, Nigeria to evaluate some growth and yield indices of tomato as influenced by five different rates of poultry manure. The experiments were carried out in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure applied in tons/ha to tomato hybrid variety UC82B obtained from an Agro-Allied Company, Ibadan, Nigeria were 0, 8, 16, 24 and 32. Parameters assessed to achieve the objective of the study were plant height and number of leaves / plant at 4 , 6 and 8 weeks after planting , number of flowers, number of fruits/plant and weight of fruits of tomato at maturity. The results of the 2-year evaluation indicated that plants which received 24 tons/ha of poultry manure were superior with mean number of flowers of 37, mean number of fruits/plant of 27 and mean weight of fruit of 36.3 tons/ha, though the mean height was 63cm and mean number of leaves was 37 at 8 weeks after planting. Based on the findings of the study, it was recommended that farmers in the study area apply poultry manure at the rate of 24 tons/ha for increased growth and yield of tomato.

Keywords: *Growth and yield indices of tomato, rates of poultry manure.*

Introduction

Tomato (*Lycopersicon esculentum* Mill) is one of the important vegetable crops grown throughout the world. Present world production of tomato is about 100 million tons from 3.7 million hectares of cultivated land (www.growtomatoes.com). It ranks second following potato in terms of area, but first as a processing crop (Alawathugoda and Dehanayake, 2014). Tomato is used in vegetarian as well as non-vegetarian dishes all over the world. In Nigeria, tomato is regarded as the most important vegetable after onions and pepper (Olaniyi *et al.,* 2010). It is used for preparing snacks, pasta salad, pizzas, sandwich and cocktails. It is rich in vitamins A and B complex which help to prevent skin and eye diseases. It is also rich in potassium which is helpful in controlling the rate of heart beat, heart diseases and stroke.

In spite of the increasing relevance of tomato to man, yield across the country continues to decline due to rapid reduction in soil fertility caused by intensive land use without adequate application of amendment materials. One of the eco-friendly agricultural practices for sustainable food production is the application of poultry manure to degraded soil. Organic manures (poultry manure) contain macro and micro elements, many vitamins, growth promoting factors like IAA, GA and beneficial micro-organisms (Natarajan, 2007, Sreenivasa *et al.,* 2010). Mohammed *et al.,* (2013) reported that poultry manure contains 1.59%N, 2.1%K, 1.21%P, 26.8%C and 5.2%Ca. Gad *et al.,* (2007) reported that poultry manure increased both fresh and dry weights of tomato shoots and roots. Moez *et al.,* (2001) found that chicken manure increased plant growth and yield of pepper more than their control counterparts grown without manure. Gaskell *et al.,* (2000) also showed that the dry matter yield of corn plants were induced by application of chicken manure. Enujeke (2013) reported that poultry manure application rate of 20tons/ha significantly increased growth and yield of cucumber higher than their control counterparts. The report further argued that poultry manure enhanced microbial activity, soil aeration, water retention, soil structure and availability of nutrients for plant use. Adesina *et al.,* (2014) reported that poultry manure significantly increased plant height, leaf area, number of leaves and number of fruits/plant of pepper more than the plants in control plate.

At present, there is no recommended standard with respect to appropriate rate of poultry manure for increased growth and yield of tomato in the study area. The objective of this study therefore was to determine the most suitable or appropriate rate of application of poultry manure for increased growth and yield of tomato in Asaba area of Delta State, Nigeria.

Materials and Methods

Description of experimental site

Field experiments were carried out at the Teaching and Research Farms of Delta State University, Asaba Campus. The experimental site is located within latitude 06°14'N and longitude 06°49'E of the equator. The experiments were conducted during the 2012 and 2013 cropping seasons in a typical humid environment that is characterized by a bimodal rainfall pattern with peaks in July and September, and an interrupted dry spell in August otherwise called (Harmattan). The annual mean rainfall is about 1,650mm, the mean annual temperature is 37.3°C and a mean relative humidity of 73.2% (NIMET, 2011). By nature of its geomorphological settings, the study area falls within the classification of Ancient metamorphic crystalline basement complex formation which are more acid than base (Egbuchua, 2007). They are essentially gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferromagnessium minerals (Egbuchua, 2007). The topography is undulating with pockets of hills, and land use is typically based on rain - fed agriculture with root, tuber, spices, pulses and vegetables prominently cultivated. The vegetation is of rainforest origin but has been drastically reduced to derived savanna due to continuous use of the land.

Field and Laboratory Studies

A land measuring 323.2 m^2 (32.0 m x 10.1 m) was selected for the study and prepared by using a tractor to plough and harrow the land. It was marked out according to the experimental layout. Fifteen plots of 60m x 2.7 m each were made and composite samples collected from the plots at 0-15 cm depth in order to assess the initial physio-chemical properties of the soil.

The composite soil samples collected from the individual plots were air-dried in a room temperature of 27°C for three days, crushed and sieved using 2 mm aperture. The parameters evaluated include the particle size distribution by hydrometer method (Gee and Baucler, 1986). The pH was determined using Pye Unican model MK2 pH meter in a 1:2:5 soil/water suspension ratio. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommers, 1982). Total nitrogen was determined by micro-Kjeldahl distillation technique as described by Breminer and Mulvaney (1982). Available phosphorus was determined by Bray No. 1 method (IITA, 1979). Exchangeable potassium was determined by flame photometer, while cation exchange capacity (CEC) was determined by Ammonium acetate saturation method (Roades, 1982).- The chemical analysis of the poultry manure used for the experiment was also evaluated using appropriate methods as described in the IITA manuals (1979).

Experimental Design

The experiment was carried out in a Randomized Complete Block Design (RCBD) with three replicates. Rates of poultry manure in tons per hectare were 0, 8, 16, 24 and 32. The composition of poultry manure used in this study was 1.4% N, 0.6% P, and 0.6% K. The manure was incorporated into the soil 2 weeks before planting.

Seed procurement, planting, data collection and statistical analysis

Seeds of proven variety of tomato (UC82B) were obtained from Agro-Allied Company, Ibadan, Nigeria. The nursery beds were prepared using hoe, seeds were broadcasted on the beds and watered regularly using a watering can, and checked for seedling emergence which started in the 5th day after sowing. The nursery plots were mulched to avoid poor germination due to excessive heat. Seedlings were transplanted to the various plots in the field at 4 weeks after sowing (WAS) after a heavy rainfall in the morning as suggested by Adelana (1978). Hoe weeding was carried out at two weeks intervals for three times. Defoliating insects were checked by spraying the plants with cymbush at 2, 4 and 6 weeks after transplanting (Vimala, 1978).

Data collected were plant height, number of leaves/plant, number of flowers/plant, number of fruits/plant, and weight of fruits of tomato. Plant height was measured from the base of the plant to the tip of the main shoot using tape rule. Number of leaves were counted at 4, 6, and 8 weeks after transplanting. The number of flowers at 50% flowering stage was counted and recorded. The number of fruits/plant was determined by counting, while weight of fruits/ha was measured using a weighing scale.

All data collected were subjected to analysis of variance and significant means were separated using Duncan Multiple Range Test (DMRT) according to Wahua (1999).

Results and Discussion

Physico-chemical properties of the experimental site

The data on the physico-chemical properties of the experimental site is shown in Table 1. The particle size showed that the soils were sandy loam in texture. Poor in fertility status, the soil had low content of organic matter (15.5 kg^{-1}) with total nitrogen of 0.87g kg^{-1}. Soil pH was strongly acid (5.3). Based on the zone's ecological ratings by FMANR (1996), the values for available (5.35 mg kg^{-1}) and water soluble K (0.17cmol kg^{-1}) were comparatively low. The CEC was 10.13 cmol kg^{-1}The low fertility status of the soil is characteristic of ultisols of humid environment with intense precipitation which causes erosion, leaching and high acidity of the ecological zone.

Table 1: Physico-chemical properties of the experimental site

Measured Parameters	Values obtained (%)
Sand	85.0
Silt	9.6
Clay	4.4
Textural class	Sandy loam
pH (H_2O)	5.3
Organic matter g kg^{-1}	15.5
Total Nitrogen (g kg^{-1})	0.87
Available P(mg kg^{-1})	5.35
Exchangeable K(cmol kg^{-1})	0.17
CEC (cmol kg^{-1})	10.13

Effects of five different levels of poultry manure on plant height of tomato

The effects of five different levels of poultry manure on plant height of tomato in 2012 and 2013 are shown in Table 2. There were significant differences in the plant height of tomato in both years of evaluation except between plants that received 24 tons/ha and 32 tons/ha of manure. In 2012, plants that received poultry manure at the application rate of 32 tons/ha had highest plant height (59cm) at 4 weeks after planting, while plants that did not receive manure (0 tons/ha) had lowest plant height of 36cm. In 2013, similar trend was observed in the plant height of tomatoes as affected by different application rates of poultry manure. Plants that received 32 tons/ha of manure also had highest plant height (61cm), while plants that did not receive manure had lowest plant height (38cm). During the 6th week, plants that received 32 tons/ha of manure had the highest plant height of 61cm in 2012, while plants that did not receive manure had lowest plant height of 42cm. In 2013, the trend did not change. Plants that received 32 tons/ha of manure had highest plant height of 65cm. This was closely followed by plants that received 24 tons/ha of manure (64cm). Plants that did not receive manure had the lowest plant height (44cm). In week 8 of 2012, plants that received 32 tons/ha of poultry manure had the highest plant height (63cm), while plant grown without manure had lowest plant height of 46cm. Similar trend was observed in week 8 of 2013 where plants that received 32 tons/ha of manure had highest plant height of 65cm, while plants grown without manure (0 tons/ha) had lowest plant height of 48cm. The superiority in plant height of tomato based on rate of poultry manure received in tons/ha was 32 > 24 > 16 > 8 > 0.

Table 2. Effects of five different levels of poultry manure on plant height of tomato in 2012 and 2013

	Weeks after planting								
	4			6			8		
	Plant height								
Rates of poultry manure (tons/ha)	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
0	36[d]	38[d]	37[d]	42[d]	44[d]	43[d]	46[d]	48[d]	47[d]
8	44[c]	48[c]	46[c]	48[c]	50[c]	49[c]	50[c]	54[c]	52[c]
16	52[b]	56[b]	54[b]	54[b]	56[b]	55[b]	58[b]	62[b]	60[b]
24	58[a]	60[a]	59[a]	60[a]	64[a]	62[a]	62[a]	64[a]	63[a]
32	59[a]	61[a]	60[a]	61[a]	65[a]	64[a]	63[a]	65[a]	64[a]

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Effects of five different levels of poultry manure on number of leaves/plant of tomato

The response of number of leaves/plant of tomato to five different levels of poultry manure in 2012 and 2013 is shown in Table 3. Application of poultry manure caused significant differences in the number of leaves of tomato in both years of evaluation except between plants that received 24 tons/ha and 32 tons/ha of manure. During the 4th week of 20112 after planting, plants received manure application rate of 32 tons/ha had the highest number of leaves/plant (25). This was closely followed by plants that received 24 tons/ha of manure (24). The lowest number of leaves (10) was obtained by plants grown without manure (0 tons/ha). In 2013, plant that received 32 tons/ha of manure also had the highest number of leaves/plant of 27, while plants that did not receive manure had the lowest number of leaves (12). During the 6th week, plants that received manure application rate of 32 tons/ha had highest number of leaves/plant (29), while plants that did not receive manure had lowest number of leaves/plant (16) in 2012. The trend did not change in 2013 where plants that received 32 tons/ha of manure had highest number of leaves/plant of 31, while plants that received 0 tons/ha of manure had lowest number of leaves/plant of 18. At 8 weeks after planting in 2012, plants that received poultry manure application rate of 32 tons/ha had highest number of leaves/plant of 37, while plants that received 0 tons/ha of manure had lowest number of leaves/plants of 22. The trend did not change in 2013 where plants that received 32 tons/ha of manure had highest number of leaves/plant of 39 while plants that did not receive manure had lowest number of leaves/plants of 24. Though there were no significant differences in number of leaves of plants that received 24 tons/ha and 32 tons/ha of manure. The superiority in the values obtained generally based on rates of application of poultry manure in tons/ha was 32 > 24 > 16 > 8 > 0.

Table 3: Effects of five different levels of poultry manure on number of leaves/plant of tomato in 2012 and 2013

	Weeks after planting								
	4			6			8		
	Number of leaves/plant								
Rates of poultry manure (tons/ha)	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
0	10[d]	12[d]	11[d]	16[d]	18[d]	17[d]	22[d]	24[d]	23[d]
8	14[c]	16[c]	15[c]	20[c]	22[c]	21[c]	26[c]	28[c]	27[c]
16	18[b]	20[b]	19[b]	24[b]	26[b]	25[b]	32[b]	34[b]	33[b]
24	24[a]	25[a]	25[a]	28[a]	30[a]	29[a]	36[a]	38[a]	37[a]
32	25[a]	27[a]	26[a]	29[a]	31[a]	30[a]	37[a]	39[a]	38[a]

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Response of number of flowers/plant of tomato to poultry manure in 2012 and 2013

Response of number of flowers/plant of tomato is shown in Table 4. There were significant differences in the number of flowers/plant of tomato. In 2012, plants that received 24 tons/ha of poultry manure had highest number of flowers/plant (30), while plants that received 0 tons/ha of manure had lowest number of flowers/plant (14). Plants that received 32 tons/ha of manure were more vegetative but had less number of flowers than plants that received 24 tons/ha. The trend was the same in 2013. Plants that received 24 tons/ha of manure had highest number of flowers/plants (34), while plants that did not received poultry manure had lowest number of flowers/plant (14). The superiority in number of flowers/plant of tomato based on rate of poultry manure received in tons/ha was 24 > 32 > 16 > 8 > 0.

Table 4. Effects of five different levels of poultry manure on number of flowers/plant of tomato in 2012 and 2013

	Number of flowers/plant		
	2012	2013	Mean
Rates of poultry manure (tons/ha)			
0	14[e]	14[e]	14[e]
8	18[d]	24[d]	21[d]
16	24[c]	28[c]	26[c]
24	30[a]	34[a]	32[a]
32	28[b]	30[b]	29[b]

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Response of number of fruits/plant of tomato to poultry manure in 2012 and 2013

The response of number of fruits/plant of tomato to five different levels of poultry manure is shown in Table 5. There were significant differences in the number of fruits/plant of tomato. In 2012, plants that received 24 tons/ha of poultry manure had highest number of fruits/plant (26), while plants that did not receive manure had lowest number of fruits/plant (12). Plants that received manure at the rate of 32 tons/ha grew more vegetative but had less number of fruits/plant (24) than plants that received 32 tons/ha of manure. Similar trend was observed in 2013. Plants that received 24 tons/ha of manure had highest number of fruits/plant (28), while plants that did not receive poultry manure had lowest number of fruits/plant (14). The superiority in number of fruits/plant of tomato based on rate of poultry manure received in tons/ha was 24 > 32 > 16 > 8 > 0.

Table 5: Response of number of fruits/plant of tomato to five different levels of poultry manure on number of fruits/plant of tomato in 2012 and 2013

	Number of fruits/plant		
	2012	2013	Mean
Rates of poultry manure (tons/ha)			
0	12[e]	14[e]	13[e]
8	18[d]	22[d]	20[d]
16	22[c]	24[c]	23[c]
24	26[a]	28[a]	27[a]
32	24[b]	26[b]	25[b]

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Response of fresh weight of fruits of tomato to poultry manure in 2012 and 2013

The response of fresh weight of tomato fruits to five different rates of poultry manure in 2012 and 2013 is shown in Table 6. There were significant differences in fresh weight of fruits obtained. In 2012, plants that received poultry manure application rate of 24 tons/ha had the highest weight of fruits (36.0 tons/ha), while plants that were grown without manure (0 tons/ha) had the lowest weight of fruits (12.4 tons/ha). The trend did not change in 2013. Plants that received 24 tons/ha of manure had highest weight of fruits (36.8 tons/ha), while plants that did not receive manure had lowest weight of fruits (13.6 tons/ha). The superiority in fresh fruit weight of tomato based on rate of poultry manure received in tons/ha was 24 > 32 > 16 > 8 > 0.

Table 6: Response of fresh weight of fruits of tomato to five different levels of poultry manure

	Fresh weight of fruits (tons/ha)		
	2012	2013	Mean
Rates of poultry manure (tons/ha)			
0	12.4^{e}	13.6^{e}	13.0^{e}
8	14.8^{d}	15.2^{d}	15.0^{d}
16	25.6^{c}	26.4^{c}	26.0^{c}
24	36.0^{a}	36.8^{a}	36.4^{a}
32	33.0^{b}	33.6^{b}	33.3^{b}

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range Test (DMRT).

Discussion

Effects of different rates of poultry manure on plant height of tomato

Plants that received 32 tha^{-1} of poultry manure had highest plant height when compared with other plants possibly because that rate of application improved moisture availability and nutrient release for enhanced apical growth. This is similar to the findings of Adekiya and Ojeniyi (2002), and Ewulo *et al.,* (2008) who reported that high rate of poultry manure increases moisture availability which leads to release of more nutrients for increased plant growth. It is also consistent with the findings of John *et al.,* (2004) who reported that poultry manure released essential elements associated with high photosynthetic activity which promoted growth of watermelon.

Effects of different rates of poultry manure on number of leaves of tomato

Plants that received poultry manure application rate of 32 tons/ha had highest number of leaves possibly because that rate released more nutrient elements for vigorous vegetative growth. This is similar to the findings of Dauda *et al.,* (2008) and Agbede *et al.,* (2008) who attributed the vigorous vegetative growth of watermelon to increased supply of nutrient elements from high rates of poultry manure. It is also in harmony with the findings of Enujeke (2013) who indicated that high rate of poultry manure increased number of leaves and other growth parameters of maize.

Effects of different rates of poultry manure on number of flowers/plant of tomato

Plants that received poultry manure application rate of 24 tons/ha had higher number of flowers/plant possibly because that rate was most appropriate for improving and maintaining soil physical condition for enhancement of crop productivity. This is synonymous to the findings of Mangila *et al.,* (2007), and Enujeke *et al.,* (2013) who reported that poultry manure improves soil physical properties reducing temperature, bulk density, and increasing total porosity for sustainable crop production. It is also consistent with the findings of Lombin *et al.,* (1992) and Agbede *et al.,* (2008) who reported that higher rate of poultry manure maintains soil physical condition that enhances crop growth and productivity.

Effects of different rates of poultry manure on fresh fruit weight of tomato

Plants that received 32 tons/ha of poultry manure had highest fresh fruit weight in both years of evaluation. This could be attributed to enhanced microbial activity, improved soil aeration, water retention and soil structure which interplayed to release macro and micro elements for increased fruit yield of tomato. This is in harmony with the findings and reports of Natarajan (2007), Screenivasa *et al.*, (2010), Gad *et al.*, (2007), Enujeke (2013), Mohammed *et al.*, (2013) and Adesina *et al.*,(2014) which indicated that high rate of poultry manure enhanced growth and yield indices of such fruit bearing vegetables as pepper, water melon, cucumber and tomato.

Conclusion and Recommendation

The study was carried out to evaluate the effects of different rates of poultry manure on growth and yield indices of tomato. The results obtained showed that poultry manure application rate of 24 tons/ha best enhanced the tested growth and yield parameters of tomato. Based on the findings of the study, it was recommended that farmers apply 24 tons/ha of poultry manure for increased growth and yield of tomato in the study area.

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