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# Evaluation of Agronomic Parameters of Potted Tomato (*Lycopersicon esculentum* (L) Mill) at Different Rates of Poultry Manure Compost

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Author JOS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author EEA managed the analyses of the study. Author AYG managed the literature searches. Author EAAI managed the field experiment and collected the data for analysis. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** The main aim of this preliminary screenhouse experiment was to examine the growth and fruit yield of a hybrid tomato (*Lycopersicon esculentum* (L) Mill) variety 'ROMA VF' at different rates of poultry manure compost (PMC).
**Study Design:** The experimental design used was the randomized complete block design (RCBD) with four replications.
**Study Area and Duration:** The trial was carried out in Calabar ($04^0$ 5'E and $07^0$ 25'E., 37 meters above sea level) located in a high rainforest area of Southeastern Nigeria from March to June in 2016 and 2015.

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**Methodology:** Five rates of PMC used as treatments were 0, 5, 10, 15, and 20 t/ha. Manure was mixed thoroughly with soil in each bucket in the ratio of 1:3. One seedling of the tomato variety, 'ROMA VF' was transplanted at four weeks old into each plastic pot perforated at the bottom in the screenhouse. Five buckets constituted the experimental unit. Pots were placed 30 cm apart within each unit and 1m between adjacent units to avoid overcrowding. The plants were supplied with water every three days throughout the experiment to avoid moisture stress. All the plants were provided with wooden stakes to support and keep them upright and off the floor. Data analysis was done using ANOVA technique and means compared using Fisher's LSD at 5% level of probability.
**Results:** Results obtained showed that 10 t of PMC/ha significantly ($P$ = .05) influenced both growth and fruit yield parameters evaluated more than other rates. This level of PMC produced tallest plants (97.7 cm) with thickest stems (2.0 cm) and the highest number of branches (25.5 branches/plant) bearing the highest number of leaves (89.5 leaves/plant) with highest leaf area (43.8 $cm^2$/plant). Plants in this treatment also produced the highest number of fruits/plant (50.3) with highest fruit weight/plant (363.9 g) and the highest fresh fruit yield of 65.57 t/ha.
**Conclusion:** Tomato responded best to PMC at 10 t/ha which could be adopted for increased productivity of tomato under screenhouse conditions in Calabar.

*Keywords: Fruit yield parameters; growth; poultry manure compost; screenhouse.*

## 1. INTRODUCTION

Tomato (*Lycopersicon esculentum* (L) Mill) is one of the most important members of the family *Solanaceae* grown world-wide for its edible fruits which have high economic, nutritional and health benefits consumed green or ripe [1,2]. Tomato is grown throughout the year and it is a strategic crop considered as one of the world's healthiest foods and contains an excellent source of vitamins A, C, biotin, vitamin B6, vitamin E, folate and niacin. It is also a very good source of copper, potassium, manganese, molybdenum, phosphorus, dietary fiber and beta-carotene. Tomato leaves are not eaten by man as they contain potentially harmful concentrations of certain harmful alkaloids [3].

Long time consumption of tomatoes is beneficial to human health including reduced risk of heart disease [4], bone health support [5], anti-cancer properties/blood building [6] and general health protection [7,8].

Tomato is highly consumed in Nigeria and the vegetable ranks third after onion and pepper [9]. The country's current tomato output of 1.8 million metric tons annually is below the annual consumption demand of 2.3 million metric tons [10], making the country one of the highest importers of tomato products. Nigeria spends as much as16 billion Naira annually on tomato import [11], a situation which aggravates the demand for the already scarce US dollars in the country.

Environmental and edaphic conditions affect tomato growth and productivity. The bulk of tomato production in Nigeria is from the Northern parts of the country where climatic conditions especially low rainfall favors the growth of the crop. The high rainfall and long rainy season prevalent in the Southern parts of Nigeria present constraints to commercial cultivation of the crop in the area. Humid conditions promote the development of pathogens, pests and diseases particularly nematodes, bacterial and fungal infections to which the crop is highly susceptible. This has led to the prevailing low yield of only about 5 - 6 t/ha in the south compared to over 20 - 30 t/ha obtained in the growing areas in the North [12].

Organic nutrient materials have been used for centuries in crop production by traditional farmers. Manures contain trace elements and major nutrients which are supplied to the crops gradually over a long period of time [13]. Regular application of manures is beneficial in crop production. It improves the soil structure, increases organic matter content of the soil and also enhances the soil's moisture and nutrient retention capacity. Organic manures are cheap and safe and are environmentally friendly in contrast to inorganic fertilizers [14,15,16].

Presently, not much research has been carried out on tomato production in Calabar and its environs compared to other fruit vegetable crops like okra and egg plant. Tomato is a fragile crop that is susceptible to a wide range of pests and diseases particularly nematodes and fungal infections which are common in the humid environments. Adoption of improved agronomic techniques and availability of suitable growth

conditions might stimulate farmers' interest in commercial production of the crop in high rainfall areas. This trial was initiated to evaluate the performance of potted tomato using poultry manure under screenhouse conditions in Calabar, Southeastern Nigeria.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The experiment was carried out in Calabar from March to June in the Crop Science screenhouse located at the animal farm area beside the soil drying shade. Calabar is coordinated on $04^0$ 57'N and $08^0$ 19'E with altitude of 37 m above sea level. The mean annual rainfall in the area ranges from 2500 to 3500 mm and mean minimum and maximum temperatures range are 27℃ and 35℃, respectively, while relative humidity is between 75 – 85% [17].

### 2.2 Methodology

Medium size plastic buckets with brim circumference of 28 cm wide, bottom circumference of 14 cm and depth of 26 cm were used to plant the 4 weeks old tomato seedlings. The buckets were filled with manure mixed with top soil collected from the arable crop field leaving about 5cm to the brim of the bucket. A sample of the soil used to fill the buckets was analyzed for the nutrient content and other relevant parameters. The soil had sandy clay texture and was acidic with pH 4.6, low organic carbon (0.45 mg/kg), low total N (0.03 mg/kg) and low nutrient elements (K, Ca and Mg), ECEC (5.73 cmol/kg ), indicating poor fertility status and needed external nutrient inputs to improve its productivity.

### 2.3 Treatments and Experimental Design

Treatments evaluated were five levels of poultry manure (0, 5, 10, 15 and 20 tonnes/ha). Manure was mixed thoroughly with soil in each bucket in the ratio of 1:3. Five buckets constituted the experimental unit and the buckets were arranged in a randomized complete block (RCB) design each in four replications. Pots were placed 30 cm apart within each unit and 1m between adjacent units to avoid overcrowding.

### 2.4 Raising and Transplanting of Seedlings

Seedlings of the tomato variety, 'ROMA VF' were raised in seedling trays in the screenhouse and nursed to transplanting maturity at 4 WAS (weeks after sowing). Two seedlings were transplanted per bucket in the evening to reduce transplanting shock and thinned to one seedling per bucket two weeks after transplanting. The plants were supplied with water regularly throughout the experiment in such a way as to avoid over watering and moisture stress to ensure normal growth. All the plants were provided with wooden stakes to support and keep them upright and off the floor to facilitate air circulation within the screenhouse.

After planting, the routine agronomic practices were carried out as at when due till the experiment was terminated.

### 2.5 Data Collection and Analysis

Crop performance indicators evaluated were plant height, stem girth, leaves/plant, leaf area, branches/plant, flowers/plant, fruits/plant, fruit weight/plant, and fresh yield/ha. Data analysis was done using ANOVA technique and means compared by LSD at 5 % level of probability.

## 3. RESULTS AND DISCUSSION

Poultry manure significantly ($P$ = .05) influenced all the vegetative parameters of tomato except stem girth which was similar in all treatments (Table 1). Tallest plants were found in plots fertilized with 20 t of poultry manure per hectare, followed by those in plots incorporated with 5 tons of the manure while shortest plants were in the control plots. All rates of poultry manure had similar effect on stem girths but plants treated with 10 t of manure had higher value than all other plants. The number of leaves and leaf area showed the same trend and were highest in the plots incorporated with poultry manure at 10 t/ha followed immediately by those in 15 and 20 t/ha, 5 t/ha and lowest in control plants. Plants that were in plots incorporated with 10 t of manure produced the highest number of branches while the unfertilized plants had lowest number of branches. The primary branches produced by plants fertilized with 10 t of the manure were longest and were followed by plants fertilized with all rates manure above 10 t/ha, 5 t/ha while unfertilized plants had shortest branches.

The fruit yield and yield components of tomato varied significantly with application of different rates of manure. These parameters increased with each rate of manure up to 10/ha, after which they declined at higher manure rates (Table 2).

**Table 1. Effect of poultry manure rates on vegetative growth parameters of tomato (*Lycopersicon esculentum* (L) Mill) in the screenhouse at 10 WAP in Calabar**

| Poultry manure rate (t/ha) | Plant height (cm) | Stem girth (cm) | Leaves/plant | Leaf area ($cm^2$) | Branches/plant | Length of first branch (cm) |
|---|---|---|---|---|---|---|
| Control | 65.1 | 1.5 | 44.8 | 14.5 | 10.5 | 10.9 |
| 5 | 77.4 | 1.8 | 54.0 | 23.1 | 13.3 | 14.6 |
| 10 | 97.9 | 2.0 | 89.5 | 43.8 | 25.5 | 18.9 |
| 15 | 105.3 | 1.8 | 86.0 | 42.3 | 23.8 | 17.8 |
| 20 | 108.2 | 1.7 | 84.5 | 41.2 | 24.5 | 17.7 |
| $LSD_{(0.05)}$ | 13.2 | ns | 7.54 | 2.39 | 1.84 | 1.21 |

*Ns: Not significant at P = 0.05*

**Table 2. Effect of poultry manure rates on fruit yield parameters of tomato (*Lycopersicon esculentum* (L) Mill) in the screenhouse in Calabar**

| Poultry manure rate (t/ha) | Fruits/plant | Fruit wt (g/plot) | Fresh fruits yield (t/ha) |
|---|---|---|---|
| Control | 18.0 | 64.3 | 12.86 |
| 5 | 30.5 | 111.3 | 22.46 |
| 10 | 50.3 | 363.9 | 65.57 |
| 15 | 46.8 | 286.8 | 54.72 |
| 20 | 34.5 | 127.3 | 46.69 |
| $LSD_{(0.05)}$ | 8.57 | 15.07 | 6.03 |

Fruit production was highest at 10 t of poultry per hectare, followed by 15 t, 20/5 t/ha and lowest in zero manure plots. Tomato plants treated with 5 and 10 tons of manure per hectare produced 12.5 and 32.3 more fruits respectively than unfertilized plants, while increasing manure to 15 and 20 t/ha reduced fruit production by 3.5 and 15.0 fruits/plant, respectively.

Fruit weight also followed the same trend with fruit production and was highest and lowest at 10 tonnes of poultry and control, respectively. A similar scenario was obtained in fresh fruit yield which increased with each incremental increase in poultry manure rate applied up to 10 t/ha after which yield decline set in. Fresh fruit yield increased by 43.11 and 52.71 t/ha representing 65.8 and 80.0%, respectively in plots respectively incorporated with 5 and 10 t of manure, whereas fruit yield was depressed by 10.85 t/ha or 16.6% and 18.88 t/ha or 28.8% by increasing manure by 5 and 10 t/ha respectively above the optimum. The highest fresh fruit yield recorded at 10 t of poultry indicated optimum rate for tomato in the study area, while the reduced fruit production capacity of tomato at rates higher than 10 t/ha might be as a result of phytotoxicity effect which weakened the plants resulting in reduced vigour.

Excess plant nutrients in the soil is not only detrimental to the crops but it also constitutes an environmental hazard by polluting underground and surface water sources. Application of optimum organic manure rates on farmland is therefore beneficial to the target crops and the environment. Incorporating 10 t of poultry manure per hectare enhanced tomato performance and should be adopted for increased productivity of tomato under screenhouse conditions in the study area.

## 4. CONCLUSION

Poultry manure compost enhanced the performance of potted tomato with the best result obtained by incorporating 10 t of the manure per hectare which could be deemed to be adequate for optimum productivity of the crop under screenhouse conditions in Calabar.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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