Comparative Growth and Yield of Roma vf Tomato Fruits with Organic and Inorganic Fertilizer

Ogunleye M.T[1], J.G. Bodunde[1], E.A. Makinde[1], O.P. Sobukola[2] and B.A. Shobo[3]

[1] Department of Horticulture, Federal University of Agriculture Abeokuta, Ogun State, Nigeria

[2] Department of Food Science and Technology, Federal University of Agriculture Abeokuta, Ogun State, Nigeria

[3] Department of Agriculture and Industrial Technology, Babcock University, Ilishan, Remo, Ogun State, Nigeria

ABSTRACT

Tomato (*Lycopersicon esculentum* Mill) is a perishable nutritive fruit vegetable with high organic acid content. It is a C3 plant which explains its low yield due to photorespiration. However, the productivity of the plant is enhanced by the use of fertilizers. The experiments were conducted at the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta (FUNAAB), between 2014 and 2015 to evaluate the effects of fertilizer type on tomato productivity. Two nutrient sources were investigated: NPK 15:15:15 (300 kg/ha); Poultry manure (20 t/ha) and the Unfertilized plots, as the control were assessed in growing tomato variety Roma VF using a Randomized Complete Block Design replicated three times. Data were collected on plant height, leaf area, number of flowers, fruit yield and unit fruit weight. Data were subjected to Analysis of Variance and the mean values were separated using Least Significant Difference at 5% probability level. Plants grown using poultry manure had taller plants, more leaves, more branches and more flowers. Plants treated with NPK 15:15:15 had higher yield and unit fruit weight in 2014 than 2015. However, there was no significant difference in the yield and unit fruit weight across treatment. In 2015, plants treated with poultry manure had higher yield and unit fruit weight than plants grown using NPK 15:15:15 and plants from the unfertilized treatment.

Keywords: *Lycopersicon esculentum*; Productivity; Unit Fruit Weight.

Corresponding author: ogunleyemt@gmail.com

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) belongs to the family *Solanaceae*. The fruit is rich in vitamins (John *et al,* 2010), minerals and lycopene, it is an excellent antioxidant (Osemwegie, *et al.,* 2010). In 2016, the world production of tomato was 843 Metric Tonnes with an estimated land area of 478,253 hectares (Factfish, 2018). Tomato is a short duration plant with high nutritive benefit, high yield and has an impressive economic value (Naika *et al.,* 2005).

Tomato, as a top ranked vegetable is rich in minerals, vitamins, essential amino acids, sugars, dietary fibres, vitamin A, B and C, iron and phosphorus (Ugonna *et al.,* 2015, Varela *et al.,* 2013). Tomato has its origin from Central and South America (Parker and Maalekuu, 2013). From Andes Mountain of Peru, it spread as a weed to extensive areas in South and Central America. Tomato is one of the most highly nutritious food ingredients used in the preparation of food all over the world (Ogunniyi and Oladejo, 2011). It is a perishable fruit and its production in the world in 2016 was about 2,243,228 tons (FAOSTAT, 2016). In land area cultivation, Nigerian ranks third highest with a coverage of 574,441 hectares (FAOSTAT, 2016). The fact presented as encouraged investigating of fruit yield potential of tomato through the use of organic and inorganic fertilizer sources.

MATERIALS AND METHODS

The nursery and field activities were carried out at the Crops Research Farm, Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Nigeria (7°25ˡ N 3°25ˡ E, 100 m above sea level) in a derived savanna. Tomato seedlings were raised in the nursery for four weeks after which they were transplanted to the main field.

Meteorological data were collected from the Meteorological Station of the Department of Water Resources Management and Agro-meteorology of the University for both years of the experiment. Samples of soil and poultry manure were analyzed in the Soil Science and Land Management Department in order to determine the available nutrients present in the soil and poultry manure. The experiment involved the use of three fertilizer types which included; Poultry manure (10 t/ha); NPK 15:15:15 (300 kg/ha) and No Fertilizer (Control). The experimental design was a Randomized Complete Block Design with three replicates. The land was cleared, mechanically ploughed, harrowed and beds were prepared manually. Weeding during crop growth was done manually with hoes. Plot size was 2 m x 2 m with an inter row spacing of 50 cm and intra row spacing as 50 cm. The tomato seedlings were transplanted into the field at four weeks old and at one plant per stand making a total of 16 plants per plot. Poultry manure was incorporated into the soil two weeks before transplanting while NPK 15:15:15 was applied at 2 weeks after

transplanting at 300 kg/ha (Bodunde and Adeniji, 2007) and control with no fertilizer application. Data were taken on the following field parameters using five sample plants per plot and data were taken weekly. Data collected were subjected to analysis of variance (ANOVA) using Gen Stat Discovery Edition 12 and the means were separated using least significant difference (LSD) at 5% probability.

RESULTS

Physical and Chemical Properties of Soil and Poultry Manure of Experimental Site

The soil used for the experiment was sandy loam in texture, and slightly acidic, with high level phosphorus (P) in 2014 and low P in 2015, moderate organic matter content and low level nitrogen (N) and potassium (K) (Table 1). The poultry manure used for the experiment was alkaline in nature with high amount of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg) -Table 1.

Table 1: Physical and chemical properties of soil and poultry manure of experimental site

Parameter	Soil		Poultry Manure	
	2014	2015	2014	2015
pH	6.50	5.50	9.40	8.90
Organic matter (%)	5.11	1.39	2.41	2.34
Total nitrogen (%)	0.21	0.06	0.18	0.38
Available P (ppm)	40.00	6.29	8.86	8.10
Exchangeable Ca (mg/kg)	0.22	5.28	53.59	53.62
K (ppm)	0.7	0.18	0.40	0.68
Mg (me/100g)	4.65	0.67	12.26	10.18
Na (me/100g)	0.75	0.25	25.00	17.75
ECEC (me/100g)	20.00	6.49		
Fe (mg/kg)	11.31	112	23.25	24.42
Zn (mg/kg)	1.34	6.1	3.80	3.60
Cu (mg/kg)	0.18	1.45	0.33	0.45
Particle size				
Sand (g/kg)	770	810		
Clay (g/kg)	2020	1890		
Silt (g/kg)	180	110		
Textural class	Sandy loam	Sandy loam		

Meteorological Condition during the Period of the Experiment

The highest rainfall observed during the field trial was in June in 2014 (116.5 mm) and 2015 (164.9 mm). Sunshine duration was at its peak in December 2014 (6.5 hr) and January 2015 (6.1 hr) during the period of the experiment. Maximum temperature was 34.6 $^{\circ}$C in December 2014 and 35.4 $^{\circ}$C January 2015 (Table 2).

Table 2: Meteorological data during the period of the experiment

	Rainfall (mm)		Sunshine (hr)		Maximum Temperature (°C)		Minimum Temperature (°C)	
	2014	2015	2014	2015	2014	2015	2014	2015
June	116.5	164.9	5.9	4.2	31.5	30.8	23.4	22.8
July	90.7	65.6	3.8	3.4	29.9	31.5	23.3	22.8
August	92.7	29.4	2.3	2.3	29.1	29.5	22.1	22.8
September	165.1	71.1	3.2	2.8	29.8	30.4	22.7	22.5
October	159.1	70.2	5.3	5.9	30.5	31.6	22.0	23.0
November	16.6	67.3	5.3	6.3	32.4	33.5	22.6	23.8
December	0.0	56.7	6.5	5.1	34.6	33.5	21.8	19.3

Source: Meteorological Station, Federal University of Agriculture, Abeokuta.

Effect of Fertilizer Types on Plant Height and Number of Leaves on Tomato

Plants treated with poultry manure were tallest compared to the other treatments in both years. There were significant differences in plant heights at 5 and 6 Weeks after Transplanting (WAT). However, at 3, 4 and 7 WAT, all the plants had similar heights. In 2015, plants treated with poultry manure had taller plants than other treatments. However, there was no significant difference in the height of the tomato plants in 2014 and 2015.

Plants treated with poultry manure had the highest number of leaves both in 2014 and 2015. In 2014, the fertilizer treatment acted similarly except at 3 WAT when plants treated with poultry manure were significantly larger in leaf production than those with NPK fertilizer and the control. In 2015, a similar trend was observed as the two fertilizers acted similarly. An increase in the number of leaves was observed in plants treated with poultry manure from 5WAT – 9 WAT where plants treated with poultry manure had significantly higher number than plants treated with NPK and the control (Figure 1).

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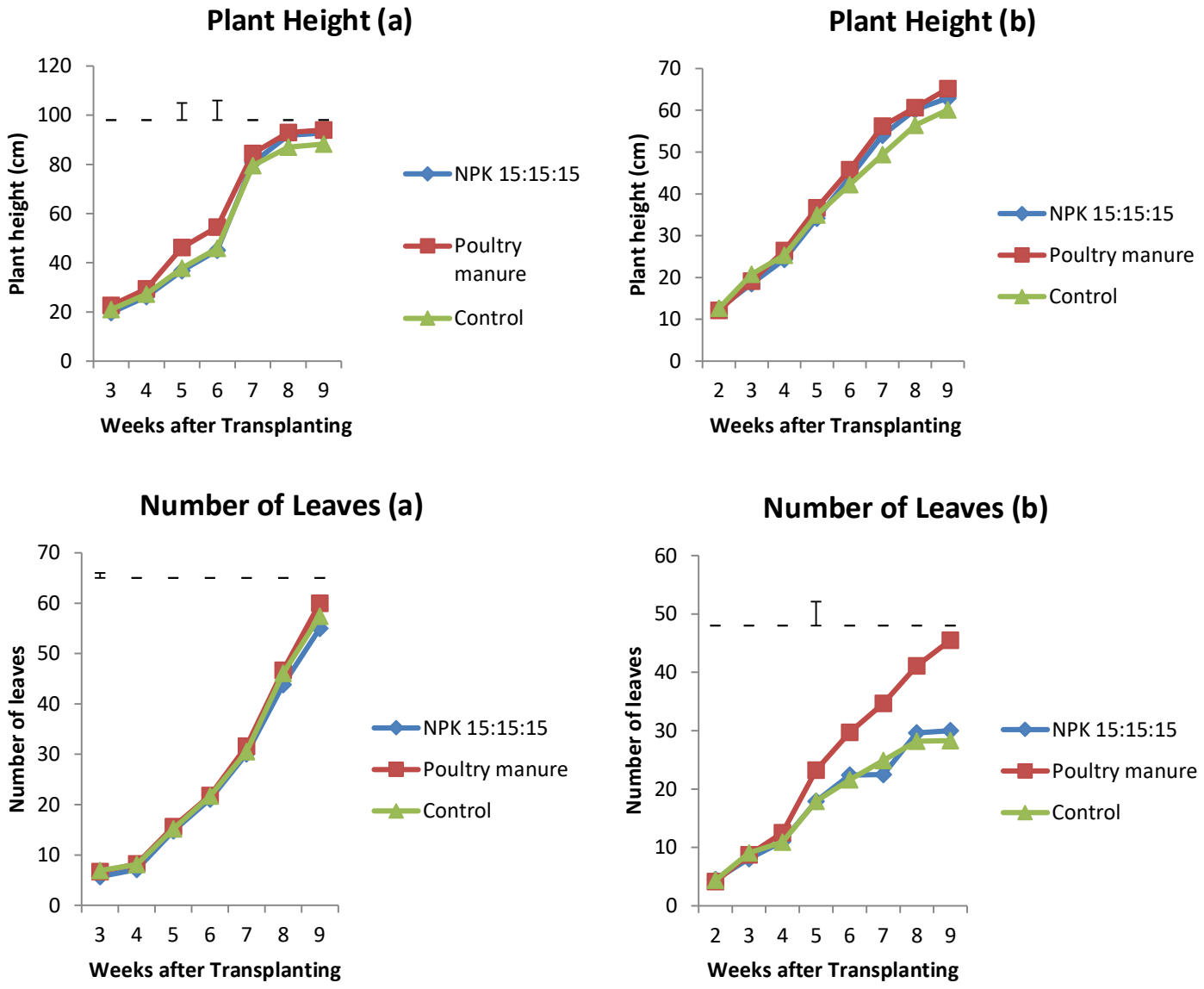
Effect of Fertilizer Types on Number of Branches and Number of Flowers on Tomato

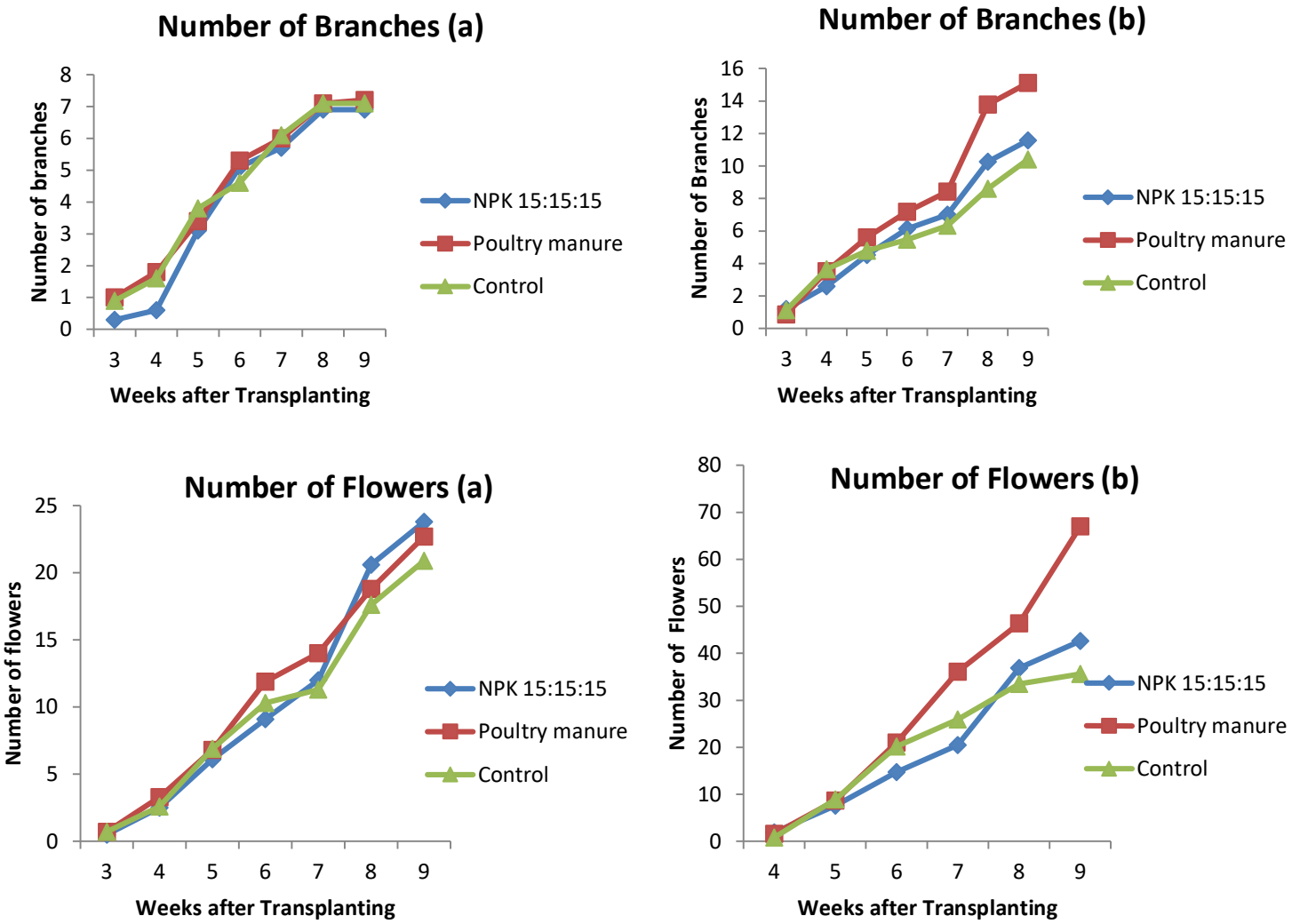
There was no significant difference all through the experiment in 2014 and 2015 in the number of branches per plant but plants treated with poultry manure had more branches compared to other treatments in both years. There was no significant difference in the number of flowers per plant all through the experiment in 2014 and 2015.



a: 2014; b: 2015

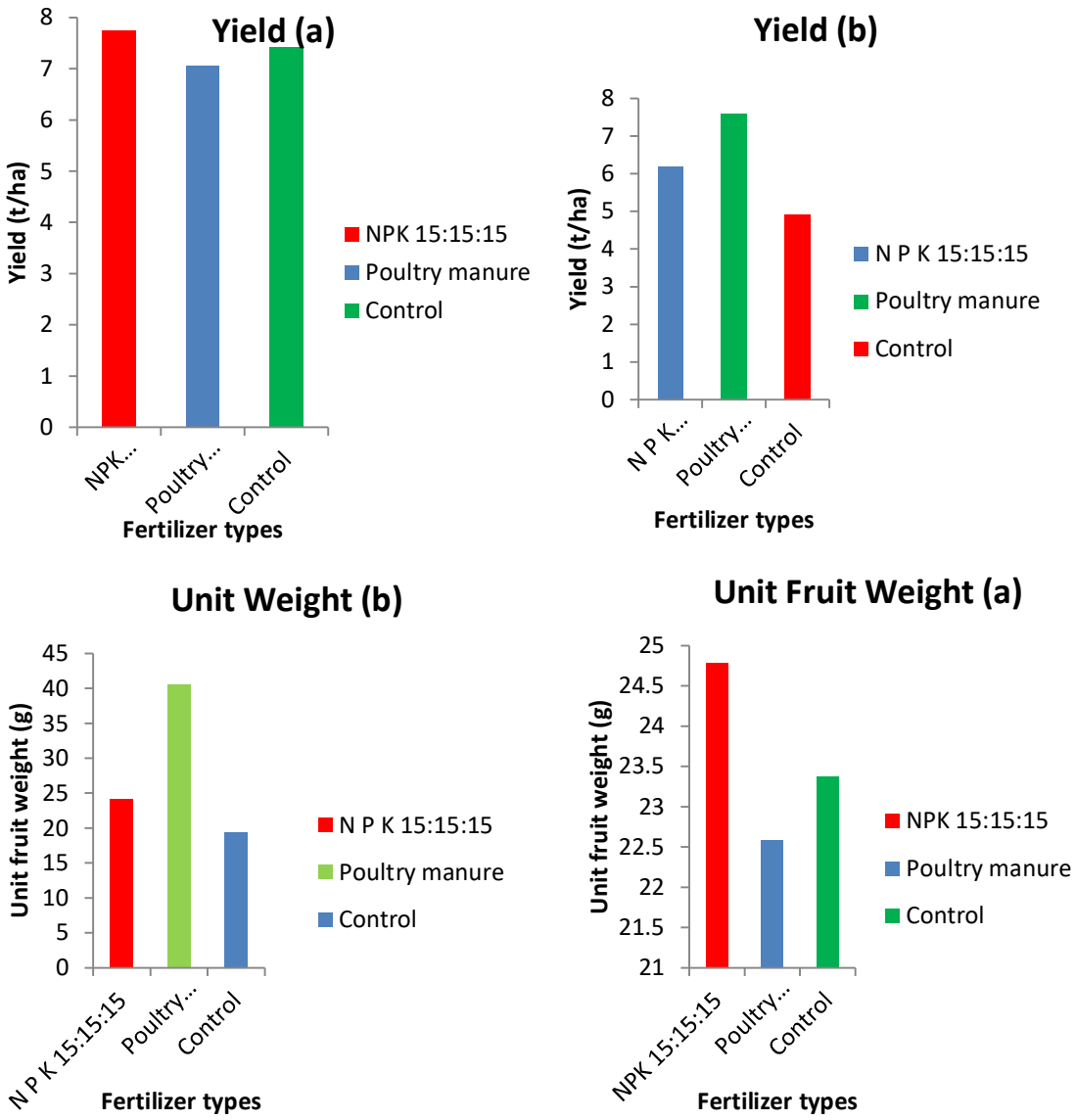
Figure 1: Effect of Fertilizer Types on Plant Height and Number of Leaves on Tomato

However, in 2014 plots treated with NPK 15:15:15 had the highest number of flowers per plant while in 2015, the plots treated with poultry manure had the highest number of flowers (Fig. 2).



a: 2014; b: 2015

Figure 2: Effect of Fertilizer Types on the Number of Branches and Number of Flowers of Tomato



a: 2014; b: 2015

Figure 3: Effect of fertilizer types on yield and unit fruit weight of tomato

Effect of Fertilizer Types on Number of Branches and Number of Flowers on Tomato

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There was no significant difference in the number of flowers per plant all through the experiment in 2014 and 2015. However, in 2014 plots treated with NPK 15:15:15 had the highest number of flowers per plant while in 2015, plots treated with poultry manure had the highest number of flowers (Figure 2).

Effect of Fertilizer Types on Leaf area on Tomato

There was significant difference in the leaf area at 4 WAT in 2014 when plants treated with poultry manure had the highest leaf area value of 111.29 cm^2 and plants treated with NPK 15:15:15 had least value of 64.65 cm^2. However, at 8 WAT there was no significant difference. In 2015 there were no significant differences at both 4 WAT and 8 WAT, although, plots treated with poultry manure had the highest leaf area value of 905.01 and 688 cm^2 ,in 2014 and 2015 respectively (Table 3).

Table 3: Effect of fertilizer types on the leaf area (cm^2) of Tomato Plant

	Leaf area at 4WAT		Leaf area at 8 WAT	
	2014	2015	2014	2015
NPK 15:15:15	64.65	210	889.13	501
Poultry manure	111.29	283	905.01	688
Control	84.04	201	941.72	383
LSD (0.05)	28.295	ns	Ns	ns

Effect of Fertilizer Types on Yield and Unit Fruit Weight of Tomato

There were no significant differences in the fruit yields of tomato under the different fertilizer treatments in both years, although, plots treated with NPK 15:15:15 had the highest yield of 7.74 t/ha and the lowest was from plots treated with poultry manure (7.05 t/ha). In 2015, plots treated with poultry manure had the highest yield of 7.6 t/ha and the least was from the plot control unfertilized with 4.9 t/ha. There were no significant differences in the unit fruit weights of tomato in both 2014 and 2015. Plots treated with NPK 15:15:15 had the highest unit fruit weight of 24.78 g followed by the control with 23.38 g and the least was from plots treated with poultry manure with 22.59 g. In 2015, plots treated with poultry manure had the highest unit fruit weight of 40.5 g followed by plots treated with NPK 15:15:15 with 24.1 g and the least of 19.4 g were from unfertilized plots (Figure 3).

DISCUSSION

The nutrients present in the soil seem adequate for the accommodation of the growth and development of tomato. Addition of extra nutrients showed no tangible increase in the vegetative or reproductive phases, implying that a native nitrogen content of 0.2% found in this soil is adequate to support plant growth and fruit yield.

The Agro-meteorological condition confirmed that tomato plant received a total of 465 mm in 2014 and 331 mm rainfall in 2015 for four months. In 2014, the tomato plant received a steady increase in rainfall from July – September while in 2015, there was a dwindling pattern in the rainfall. This might have resulted in the increased yield in 2014 than those produced in 2015. Ismaeil *et al*., 2012 confirmed that the use of poultry manure increases the growth attribute and forage yield. This was in line with the result obtained as plants imposed with poultry manure were taller than other treatment.

Use of poultry manure increased the number of branches in the tomato plant agreeing with Uko *et al.,* (2013) that the use of poultry manure increases vegetative growth of water leaf. The increased number of flowers with N P K 15:15:15 treatment than that of poultry manure was in contrast to Olowoake and Ojo, (2014) that stated that organic manure increases the vegetative character of *Amaranthus caudatus.* The peak of the release of nutrient of poultry manure was experienced at the fourth week while the N P K 15:15:15 had exhausted its nutrient release.

The Low yield experienced in 2015 could be attributed to flower abortion experienced by plants. This condition was more glaring in plants treated with N P K 15:15:15. This was similar to the report of Makinde *et al.,* (2016) that tomato fruits treated with N P K 15:15:15 had higher flower abortion than plants treated with organic fertilizer. The low yields in 2015 could be as a result of the low rainfall experienced during the life span of the tomato plant. Observed fruits from plants treated with poultry manure that had higher weights than from other treatments could be due to the available nutrients present after the manure had hydrolyzed. Hence, the available photosynthate was higher for plants treated with poultry manure than those treated with N P K 15:15:15 and from the unfertilized plants.

CONCLUSION

Addition of poultry manure increased the amounts of nutrient available for plants metabolic activity; as the nutrients were released in available forms over a period of time for the use of the plant. For bountiful harvest, poultry manure applied at 20 t/ha is recommended in the tropics for the production of tomato. For acceptable fruit size, it is advised to grow tomato using NPK 15:15:15 at 300 kg/ha.

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