Original Research Article

Comparative Study of Tomato (Solanum lycopersicum L.) Cultivation through Organic and Conventional Farming

.**ABSTRACT**

As organic farming gains popularity worldwide, it is crucial to investigate the potential benefits of using poultry manure as an organic fertilizer source. This study aimed to assess the comparative performance of tomato cultivation under organic and conventional farming practices, with a specific focus on the effects of varying rates of poultry manure applications. The research was carried out at the Teaching and Research Farm of College of Agriculture Science and Technology Jalingo, Taraba State, Nigeria. This was conducted during the 2021 cropping season (April - June) with four levels of poultry manure. Three (3) application rate of poultry manure (5.0 tha^{-1}, 8.0 tha^{-1}, and 11 tha^{-1}) was used to compare with the control/check with no application of poultry manure, all replicated four times in a randomized complete block design. The objective of this research was to determine the impact of different rates of poultry manure application on tomato growth and yield potentials. After a thorough evaluation of the experimental plots, it was found that the treatment with 11tha^{-1} of poultry manure demonstrated superior performance compared to the other treatment levels. The tomatoes grown with this application rate exhibited significantly higher yields and improved plant vigor, as confirmed by the recorded data. The study's findings provide valuable insights for local farmers, as this research supports the use of 11 tha^{-1} poultry manure application as an effective strategy to enhance tomato cultivation and maximize yield potential. The necessity of conducting this research arises from the need to optimize tomato cultivation practices and address the growing demand for sustainable and environmentally friendly farming methods. The study also provides evidence that the application of 11 tha^{-1} poultry manure significantly improves tomato cultivation outcomes. The results obtained underline the relevance of optimizing nutrient management practices in organic and conventional farming systems, fostering enhanced yield potential, and promoting sustainable agricultural practices for future food security.

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Keywords: Poultry Manure, Tomato, Growth, Yield.

1. INTRODUCTION

"Tomato is one of the most important fruit crops in the world. It ranks second in importance to potato in many countries" (Parray *et. al.,* 2007). "Tomato belongs to the family Solanaceaes, a member of the genius Lycopersicon. Lycopersicon species are native of Ecuador, Peru, and the Galapagon Island, though most evidence suggests that the site of domestication was Mexico" (Sarah *et al.,* 2010). "Tomato was introduced to West Africa and Nigeria in particular at the end of the 19th century" (Tswanya *et al.,* 2017).

"Tomato (*Solanum lycopersicum L.*) is one of the most popular and widely grown vegetable crops in the world and ranks number one in their contribution to the diet, hence consumed in large quantities. In Nigeria, tomato is a special ingredient in the food of both the poor and the rich. The tomato stew is eaten with relish, especially on Sundays and during festivals while the fruits are eaten raw or cooked and can be processed into soup, juice, sauce, ketchup, puree, paste and powder" (Olaniyi and Ajibola, 2008). "Its fruits are cheap and rich sources of vitamins (vitamin C, A, B and K), minerals (potassium, calcium, sodium, magnesium, phosphorus, boron, manganese, zinc, copper, iron, etc.), and organic acids (citric, malic and acetic acids) which are known as health acids" (Meena *et al.,* 2014). "Tomatoes are important source of lycopene; the most important antioxidant that has been linked with reduced risk of prostrate and various other forms of cancer as well as heart diseases" (Tswanya *et al.,* 2017).

"The bulk of fresh market tomatoes are produced by small-scale farmers. Farmers are interested in tomato production more than any other vegetables for its multiple harvests, which result in high profit per unit area. The realization of profit depends on market revenues. The realization of profit also requires increased production efficiency using modern inputs and technologies" (Venance, 2018).

"Tomato is grown all over the world. China, USA, Turkey, Italy, Egypt, India, Spain, Brazil, Iran and Mexico are the major producers" (Mehmood *et al.,* 2012). "The plant grows up to 1-3 meters (3-10ft) in height and has a weak stem that often sprawls over the ground and vines over the plants. It is a perennial in its native habitat, although often grown outdoors in temperate climates as an annual. In Nigeria, tomato crops are grown during both the wet and dry seasons but they attract higher profits during the dry season when the demand is higher than the supply" (Olaniyi and Ajibola, 2008).

According to the Nigerian Agro-business Group, as reported by daily Nigeria newspaper said that northern Nigeria produces 98% of the tomatoes consumed annually in the country.

"Small scale productions are prevalent in family gardens and small neighbourhood farms in the Southern Guinea Savannah and Rain Forest regions of Nigeria. Small scale farming is a farming system where the management of the farm is done by the farmer and his family and the surplus of their products is being sold in the market. Decreasing soil nutrient quality and rising cost of inputs, especially fertilizer, plague tomato production in Nigeria, resulting in the dwindling yields of tomato plants in the country" (Ogunwole *et. al.,* 2006).

Total cultivation area in Nigeria for the production of tomato was 1.27 lakh ha and the production quantity was 8.89 lakh tonnes given an average of 7 tons per hectare (Law-ogboma, and Egharevba 2008). This yield is below African average which is 20.5 tonnes per hectare (Food and Agriculture Organisation, 2003).

"Among the factors affecting tomato productivity is soil fertility; which is defined as the capacity of soil to provide physical, chemical and biological needs for the growth, productivity, reproduction and quality, related to plant and soil type, land use and climatic conditions" (Abbott and Murphy, 2007). "Decrease in soil fertility after few years of cropping is a major limitation in sustaining crop productivity and ensuring food security" (Ewulo *et al.,* 2016). "To increase the soil fertility and yield, inorganic/chemical fertilizers are often used. Although chemical fertilizers have been considered as the most important contributor of increasing agricultural productivity in the world, the negative effects of chemical fertilizer on the soil and environment limits its usage in sustainable agricultural system" (Adekiya and Agbede, 2017). Chemical fertilizers accumulate heavy metals in plant tissues which compromises fruit nutrition value and edible quality (Shimbo *et al.,* 2001) and increase the concentration of nitrate in ground water, rivers, and lakes (Ajdary *et al.,* 2007). Moreover, vegetables and fruits grown on chemically over fertilized soils are more prone to attacks by insects and diseases (Karungi *et al.,* 2006) as well as about 50 percent of applied inorganic fertilizers are lost either through leaching or through volatization (Gosavi *et al.,* 2010). "The high cost of chemical fertilizers and their adverse effect on soil biological process and human health makes one to think for alternative sources of manures" (Arahunashi, 2011).

Application of organic fertilizer is an important means of maintaining soil fertility status and is also environmental friendly. This is because nutrients contained in organic manures are released more slowly and are stored for a longer time in soil, thereby ensuring a long residual effect (Sharma and Mittra, 1991). In many tropical soils, organic manure has been reported to be the major sources of nitrogen phosphorus, potassium, calcium as well as magnesium (Awodun, 2007).

A study conducted by (Akanbi *et al.,* 2005) and (Olaniyi and Ajibola 2008) shows that 9-18 tons/acre of manure is appropriate for good tomato production, application of broiler liter at the rate of 15t/ha, N at 40kg/ha, P at 30kg/ha and K at 30kg/ha gave higher growth of fruit yield. Organic manure when properly applied has the potentials of improving soil infiltration capacity, as well as impact beneficial effects on the structure of the soil (Olaniyi and Ajibola 2008).

Therefore, this experiment aims to study the growth and yield of tomato in response to different rates of poultry manure in Jalingo Taraba State Capital.

2. MATERIALS AND METHODS

2.1 Study Area

Field experiment was conducted at the teaching and research farm College of Agricultural Science and Technology Jalingo (8°53N/, 11°18E/) of the Greenwich meridian during the 2021 cropping season to determine the growth and yield of tomato in response to different rates of poultry manure. Jalingo is located at the Northern Guinea Savanna Agro-ecological Zone of Nigeria and located in the northern part of Taraba State. The Local Government is bounded by Ardokola, Zing, and Yoro Local Government respectively. Dry season last for a minimum of five months (November to March) while the wet season spans from April to October. Mean annual rainfall ranges from 800mm - 2000mm (Abel and Emeka 2016). The site was cleared manually using local implement.

2.2 Experimental Design

There were three (3) levels of poultry manure without liters over control (i.e 0.00tha^{-1}). These gave a total of four treatments. The treatments were replicated four time in a Randomize Complete Block Design (RCBD) giving a total of sixteen (16). The treatments were as follows: Control, 5.0 t ha^{-1}, 8.0 t ha^{-1}, and 11.0 t ha^{-1} on a dry weight basis.

2.3 Land Preparation/Nursery Sowing

Seed beds measuring 3×3 m and 0.5 m apart were prepared to a fine tilt. The poultry manure obtained from the college poultry farm was cured by air drying under shad and was incorporated manually with hoe after broadcasting at different rates, two weeks prior to transplanting. The poultry manures were applied at 0.0, 5.0, 8.0 and 11.0 t ha-1. Seeds were sown by drilling, covered with dead grasses and watered. Germination occurred after four days of sowing. Fresh water was supplied every morning using water can to avoid wilting and for normal plant development. Weeding was done manually by hands after every one week until the seedlings were ready for transplanting.

2.4 Transplanting

Transplanting was done in the evening when tomato seedlings were four weeks old and transplanted at a spacing of 75×75 cm (35,556 plants ha^{-1}). The ball of earth method of transplanting was used.

2.5 Soil/Poultry Manure Analysis

Soil analysis of the experimental site prior to planting was based on the composite samples taken randomly at the four different blocks of the experimental unit at 0 – 15 cm depth with the aid of an auger. The soil samples after air dried in the laboratory was saved with 2 mm sieve then routine soil analysis was carried out to determine the values of chemical and physical properties of the soil as shown in Table 1. The poultry manure used was dried and sieved with 2 mm sieve for chemical analysis to determine its nutrient composition results are presented in Table 1.

2.6 Statistical analyzes

The growth parameters which includes; plant height, number of primary branches was measured at two weeks intervals immediately after transplanting. The plant height was measured with the aid of a meter rule from the base of the plants. The yield parameters were also measured at two weeks interval with effect from week 6 includes; number of trusses, flowers and fruits per plant respectively. While fruit yield and seed yield weight kg ha^{-1} were also measured to make up the yield parameters at the end of the experiment. The growth and yield parameters collected was subjected to analysis of variance after which means that shows significant F-test values were separated using the Ducan Multiple Range Test (DMRT) at 5% level of probability.

3. RESULTS

Table 1: The results for the physical and chemical properties of the soil indicated that soil pH recorded value of 6.40, organic carbon of 0.42 %, total nitrogen 0.19 %, Available phosphorus 11.03 Mg kg^{-1}, effective cation exchange capacity of 8.78 Meq $100g^{-1}$ exchangeable acidity 6.40 Meq $100g^{-1}$. silt, clay and Sand recorded values of 9.0%, 7.2% and 83.8% and the exchangeable cations was also determine in Meq 100-1 (K^+ 0.25, Na^+ 0.78, Ca^{2+} 0.7 and Mg^{2+} 0.61). The following where the values recorded for the chemical properties of poultry manure (PM); pH recorded 7.20, organic carbon 9.30, nitrogen 2.24, phosphorus 6.80, potassium 8.03, calcium 4.02, magnesium 0.55 and sodium 0.15.

Plant height was significantly affected by various treatments of poultry manure (PM) at 4 weeks after planting (4WAP). The average plant height increased with different levels of the PM used. The highest plant height was obtained at 11.0 t ha^{-1} PM (Table 2). The number of primary branches at 4WAP was significantly affected at 8.0 and 11.0 t ha^{-1} PM while treatment with 0.0 and 5.0 t ha^{-1} were statistically the same (Table 2).

The growth parameters that were measured at 6WAP (plant height and number of primary branches) Table 3. Plant height shows significant increase at all levels of PM application with the control recording the least value of 19.87 cm which was also statistically different from other treatments (Table 3). Number of primary branches recorded increases from one level of the treatments to another, the application of PM at 5.0 and 8.0 t ha^{-1} were statistically the same. The control has the least value of 2.12 and was statistically the same to the treatment with 5.0 t ha^{-1} PM which recorded 3.54 (Table 3).

Plant height at 8 WAP shows that the application of PM at 5.0 and 8.0 t ha^{-1} where statistically the same while the control with 0.0 and the treatment with 11.0 t ha^{-1} PM where statistically different with 26.23 cm and 40.21 cm when compared to 5.0 and 8.0 t ha^{-1} PM which were statistically the same (Table 2). At 8 WAP there was a significant different between the treatment with 0.0 and 5.0 t ha^{-1} PM with the value 3.78 and 5.43 while 8.0 and 11.0 t ha^{-1} PM was statistically the same (Table 4).

The effects of poultry manure was observed on the yield parameters measured (number of trusses, flowers and fruits of tomato) at 6WAP Table 5. This result shows that 5.0 and 8.0 t ha^{-1} PM where statistically the same for number of trusses $plant^{-1}$ and numbers of flowers $plant^{-1}$ respectively while 0.0 and 5.0 t ha^{-1} PM treatment for number of trusses $plant^{-1}$ and numbers of flowers $plant^{-1}$ were statistically different (Table 5). Number of fruits $plant^{-1}$ was significantly affected by various treatments of PM at 6WAP. The treatment with 11.0 t ha^{-1} PM recorded the highest number of fruits (12.66) while the control with no application of PM recorded the least with 2.12 fruits (Table 5).

From Table 6 it was observed that the number of trusses $plant^{-1}$ was statistically the same for 5.0 and 8.0 t ha^{-1} PM while the highest value was recorded at 11.0 t ha^{-1} which was statistically different to other levels applications including the control which recorded the least of 12.88 (Table 6). The number of flower per plant was statistically different at all levels of PM application with the control recording the least of 6.21 while the treatment with 11.0 t ha^{-1} recorded 18.28 which ranked the highest (Table 6). The number of fruits $plant^{-1}$ was statistically different for 0.0 and 5.0 t ha^{-1} PM treatments while the application 8.0 and 11.0 t ha^{-1} PM was statistically the same. The lowest number of fruits was obtain at the treatment with 0.0 t ha^{-1} while the application of 11.0 t ha^{-1} recorded 38.18 which ranked the highest number of fruit.

The effects of different rates of poultry manure on tomato fruit yield were statistically different at 0.00 and 5.0 t ha^{-1} PM application with the control recoding the least of 4808.3 kg ha^{-1}. It was also observed that 8.0 and 11.0 t ha^{-1} PM application were statistically the same with the value of 8257.66 and 9069.14 kg ha^{-1} respectively (Table 7). Seed yield kg ha^{-1} were statistically the same for 0.0 and 5.0 t ha^{-1} PM application with the value 16.33 and 16.82 kg ha^{-1} while 8.0 and 11.0 t ha^{-1} PM application were also statistically the same with vale 19.03 and 20.62 kg ha^{-1} respectively (Table 7).

Table 1: Physico-chemical properties of soil sample of the experimental site and poultry manure used

Soil Properties	Soil Samples Values	Poultry Manure	
		Properties	**Values**
Sand	83.8	pH	7.20
Silt	9.0	Organic C (%)	9.30
Clay	7.2	Nitrogen (%)	2.24
pH (H_2O 1:2.5)	6.40	Phosphorus (%)	6.80
Organic Carbon (gkg^{-1})	0.42	Potassium (%)	8.03
Total Nitrogen	0.19	Calcium (%)	4.02
Available P (mg kg^{-1})	11.03	Magnesium (%)	0.55
Exchangeable Bases (cmol kg^{-1})		Sodium (%)	0.15
Na^{+}	0.78		
K^{+}	0.25		
Ca^{2+}	0.74		
Mg^{2+}	0.61		
CEC	3.65		

Table 2: Effects of different rates of poultry manure on number of branches and plant height of tomato at 4 weeks

Treatment (t ha^{-1})	Plant Height (cm)	Number of Primary Branches
Control	13.87^{b}	1.85^{b}
5.0	18.85^{c}	2.64^{b}
8.0	23.57^{d}	3.15^{c}
11.0	29.12^{a}	4.04^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

Table 3: Effects of different rates of poultry manure on number of branches and plant height of tomato at 6 weeks

Treatment (t ha^{-1})	*Plant Height (cm)*	Number of Primary Branches
Control	*19.87*^{d}	2.12^{c}
5.0	*25.37*^{c}	3.54^{b}
8.0	*28.75*^{b}	4.95^{b}
11.0	*34.69*^{a}	5.19^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

Table 4: Effects of different rates of poultry manure on number of branches and plant height of tomato at 8 weeks

Treatment (t ha^{-1})	Plant Height (cm)	Number of Primary Branches
Control	26.23^{d}	3.78^{c}
5.0	34.07^{b}	5.43^{b}
8.0	36.58^{b}	6.85^{a}
11.0	40.21^{a}	7.79^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

Table 5: Effects of different rates of poultry manure on number of trusses, flowers and fruits of tomato at 6 weeks

Treatment (t ha^{-1})	No. of trusses Plant $^{-1}$	No. of flowers Plant $^{-1}$	No. of fruits Plant $^{-1}$
Control	6.17^{c}	12.38^{c}	2.12^{d}
5.0	20.40^{b}	28.21^{b}	6.16^{c}
8.0	27.74^{a}	52.71^{a}	8.29^{b}
11.0	29.12^{a}	66.12^{a}	12.66^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

Table 6: Effects of different rates of poultry manure on number of trusses, flowers and fruits of tomato at 8 weeks

Treatment (t ha^{-1})	No. of trusses $Plant^{-1}$	No. of flowers $Plant^{-1}$	No. of fruits $Plant^{-1}$
Control	12.88^{d}	6.21^{d}	18.68^{c}
5.0	26.83^{b}	10.73^{c}	26.83^{b}
8.0	32.65^{b}	13.87^{b}	32.52^{a}
11.0	35.18^{a}	18.28^{a}	38.18^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

Table 7: Effects of different rates of poultry manure on tomato fruit and seed yield

Treatment (t ha^{-1})	Fruit Yield (Kg ha^{-1})	Seed Yield (Kg ha^{-1})
Control	4808.33^{c}	16.33^{b}
5.0	7418.33^{b}	16.82^{b}
8.0	8257.66^{a}	19.03^{a}
11.0	9069.14^{a}	20.62^{a}

Means followed by the same letter(s), within each column are not significantly different at p>0.05 level of probability using DMRT

4. DISCUSSION

The data on initial properties of soil at the sites of experiment are present in Table 1. The result indicated that the soils were loamy sand with high sand particle. The soils pH was slightly acidic, organic carbon was low, available phosphorus was moderate, moderate effective cation exchange capacity (ECEC), exchangeable cations are moderate except for calcium (Ca^{2+}) which was low and the total nitrogen level in the soil was also moderate, hence the need for additional nutrient amendment to the soil in order to boost production. The poultry manure chemical properties indicated that the PM was rich in plant nutrients and the acidity was near neutral.

The vegetative growth and yield performance of a plant is directly linked to the soil fertility status and the environmental conditions sounding the plant. In this study we could observed that the growth and yield parameters of Tomato measured increases as Poultry Manure increases from one level of treatments to another Table 2, 3, 4, 5, 6 and 7 respectively, which is in agreement to the findings of (Brempong and Addo-Danso 2022) who reported that; Organic fertilizers supply all essential crop nutrients (N, P, K, S, Ca, Mg, B, Cl, Cu, Fe, Mn, Mo, Ni and Zn) in balanced forms, including micronutrients.

During the vegetative stage (Table 2 - 4) we could see that the growth parameters measured (plant height and number of primary branches) increased from one level of PM application to another with the control having the least value across all parameters which is evidence that PM has the capacity of increasing the fertility status of the soil which in turn increase the vegetative growth of the Tomato plant (Table 2 - 4) supporting the findings of (Musa *et al.,* 2020) who reported that the addition of organic manure increased the soil chemical properties which invariably enhanced crop yield and productivity.

The height of plant is an important growth characteristic directly linked with productive potentials of plant in terms of fodder, grains and fruit yield (Omotoso and Shittu 2007). At 4 and 6 WAP the different rates of poultry manure shows significant increase on plant height of tomato (Table 2, and 3) while at 8 WAP there was no significant different between 5.0 and 8.0 t ha^{-1} PM application, this could be attributed to environmental condition at the site of experiment.

It was also observed that as the plants gets taller the number of primary branches also increased. The control plot recorded the shortest plant and also have fewer primary branches (Table 2, 3 and 4) respectively suggesting that fertilization enhances the growth of tomato. The significant increase of number of primary branches in the treated plots suggest more number of fruits and invariably more tomato yield which is the ultimate goal of the farmer. This agreed with the work of (Ayeni *et al.,* 2010) and (Ilodibia and Chukwuma 2015) who reported significant increase in plant height, number of branches and number of leaves as a result of application of poultry manure on Tomato plant.

The yield parameters measured includes number of trusses, flowers and fruits per plant (Table 5 and 6). At 6 WAP it was clearly observed that there was significant differences ($p<0.05$) among the different rates of poultry manure applications. This is attributed to the sufficient release of nutrients particularly N.P.K contain in the poultry manure applied, as these nutrients improve the growth and yield of crops. This result is in line with the findings of (Ilodibia and Chukwuma 2015) who found out that the number of fruits and leaves of crop significantly increased with increase in the concentration of poultry droppings. More flowers were produced and few fruits were produced, this is because at this stage the plant is set for pollination (Table 5). At 8 WAP we could see that the number of flowers has transformed into fruits which led to the increase in fruits while the number of flowers drops. It is an indication that pollination has taken place and other flowers must have fallen down due to some environmental conditions (Table 6). We could see that plants which perform better at the vegetative stage produces more fruits in agreement to the findings of (Omotoso and Shittu 2007) who reported that the height of plant is an important growth characteristic directly linked with productive potentials of plant in terms of fodder, grains and fruit yield.

Poultry manure significantly affect fruits and seeds of tomato from one level of application to another (Table 7). It was also observed that the application of 11.0 t ha^{-1} rate of poultry manure gave the highest fruit and seed yield of 9069.14

kg ha^{-1} and 20.62 kg ha^{-1} respectively which could be as the result of the high vegetative growth performance that were recorded during the vegetative stages (Table 2, 3, and 4). This is in line with the findings of (Ilodibia and Chukwuma 2015) who reported that tomato fruit weight increased with increasing manure source. In comparison with the control, poultry manure treated plots had significantly higher yield than the control (Table 7).

5. CONCLUSION

This study showed the potential of increasing growth and yield of Tomato (*Solanum lycopersicum L.*) using poultry manure. It was noticed that there were significant increases in some of the growth and yield parameters that were measured in the various rates of poultry manure (0.00 t ha^{-1}, 5.0 t ha^{-1}, 8.0 t ha^{-1}, and 11.0 t ha^{-1}) that was applied as treatment. Plants treated with 11.0 t ha^{-1} performed better compared to plants treated with the other rate of poultry manure including the control under the conditions of this experiment.

6. RECOMMENDATION

Based on the results and conclusion drawn from the research it is recommended that Tomato (*Solanum lycopersicum L.*) verity Roman VFN can be best grown with poultry manure at the rate of 11.0 t ha^{-1} is recommended for local farmers in the Northern Guinea Savanna Agro-ecological Zone of Nigeria.

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