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Original Article

Effects of different organic manure on growth, yield and quality of garden egg (*Solanum melongena*) in Ondo State, Nigeria

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ABSTRACT

A field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure, Ondo State, Nigeria, in the early cropping season of 2016 to examine effects of manure types and rates of application on soil properties, growth, yield and quality of garden eggs (*Solanum melongena*). The experiment was laid out in a randomized complete block design (RCBD), with three replications. Poultry manure, compost, sunshine manure, fertiplus and cow dung were the selected manures. Soil samples were also collected before planting and at harvest forphisico-chemical analysis. The growth parameters assessed were: plant height (cm), stem girth (mm), number of branches per plant, and number of leaves per plant; while the yield parameters were number of fruits per plant, weight of fruits and proximate composition of fruits. Results from the study showed that application of manure had positive effects on growth of *Solanum melongena*, yield and quality. Cow dung had higher fruit yield at maturity weighing 2773.92/g. The proximate composition of the garden egg showed that the percentage ash, crude protein, crude fibre, fats and moisture contents differed significantly ($p < 0.05$) across treatments. The highest percentages of moisture content and crude protein were in garden eggs in plots treated with cow dung. *Solanum melongena* in plots treated with poultry manure had the highest percentage of ash while *Solanum melongena* in plots treated with sunshine manure had the highest percentage of fat. The results revealed cow dung as the most effective at improving growth and yield of *Solanum melongena*

K E Y W O R D S : *Manure, Garden egg, Growth, Physico-chemical, Yield*

INTRODUCTION

Garden egg (*Solanum melongena*) is one of the major vegetables grown in West Africa. It belongs to the family of Solanaceae, and genus *Solanum*. Garden egg is known by several names like, “bringal” in South East Asia and only known as garden eggs in West Africa (Khald et al., 2014). The crop is cultivated in tropical and sub-tropical regions of the world including Africa, America and Asia. The plant is a short-lived annul crop, branching in habit with a height of 0.5 to 1.5 m. It is usually grown for either the immature fruits or leaves depending on the locality.

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The immature fruits are eaten raw or cooked. The green fruits are consumed fresh and served to visitors as cola in 'homes' and the red fully matured fruits are used to make stews (Agbo and Nwosu, 2009). It is also an important vegetable due to its nutrient value. It supplements starchy foods in addition to being good source of protein, minerals and vitamins (Mpang et al., 2021). *Solanum melongena* fruit aids in lowering blood cholesterol levels, and in regulating high blood pressure.

In contemporary agriculture, continuous farming is replacing bush fallowing which has led to the addition of nutrients and organic matter to the soil. Also, the physical properties of the soil are being depletedbecause ofexcessive use of fertilizer. Moreso, tropical soils are adversely affected by sub optimal soil fertility and erosion, causing deterioration of the nutrient status and change in soil organism population. Hence there is the need to investigate ways of improving the physical properties of soil and the right amendment to enhance growth, quality and yield of garden eggs while maintaining the fertility status of the soil.

One of the ways of increasing the nutrient status is by boosting the soil nutrient content is the use of organic materials (poultry manure, other animal waste and use of compost) and inorganic fertilizers (Mpanga et al., 2021). Although, inorganic fertilizer is also effective in improving crop yield and nutrient availability, however, its use is limited due to scarcity, high cost, nutrient imbalance and soil acidity. Whereas, application of organic manure has been reported to supply plant nutrients and improve the soil structure (Ullah *et al.*, 2008). Earlier reports by Anoop and Chauban, (2009), revealed that application of manure showed a significant increase in yield than inorganic fertilizer in garden egg production. Apart from the manual itself, the rate of manure application was also shown to influence growth and yield of plants (Premsekhar and Rajashree, 2009). Furthermore, it is essential for establishing and maintaining the optimum soil physical condition for plant growth. Poultry manure is also very cheap and effective as a good source of N for sustainable crop production (Paul et al., 2017). Therefore, the aim of this experiment is to investigate the effects of different manuals on growth and yield of garden egg.

MATERIALS AND METHODS

Description of experimental location

Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology Akure, Ondo State Nigeria between July to October 2016. The site lies within the tropical rainforest belt, latitude 5°N and longitude 15°E. The rainfall pattern of Akure is bimodal with a wet season of about eight months occurring from April to October and with a brief dry spell, which in most cases occurs in the second half of August. The peak rainfall periods are June, July, September and October while the short dry season is from November, December through February and March. The mean daily temperature in Akure ranges from about 25°C and 37°C. The site has been cultivated in previous years continuously for vegetables, maize and tuber crops.

Collection of samples and treatments

The garden egg variety used for this experiment was obtained locally from Shasha market in Akure. Cow dung and poultry manure were obtained from livestock unit of Agricultural Development Program of Ekiti State Ministry of Agriculture while FertiPlus and Sunshine were obtained from an Agro-allied company in Akure, Ondo State, Nigeria. The Cow dung and Poultry manure were cured by air drying them for two weeks before they were applied on the field.

Experimental design

The experiment was set out in Randomized complete block design (RCBD), and replicated four times. Each replicate represent a block with twenty treatments. The land was divided into 20 plots with each plot measuring 6.3 m × 5.2 m. A 1m alley was left between plots and 2 m alley between blocks. Each plot was carefully labeled.

Nursery preparation and transplanting

Nursery beds measuring 2 m long and 1.2 m wide were prepared. Seeds were sown thinly in rows. The seed beds were watered and covered with mulch after sowing. After emergence the mulch was removed and shade was erected to protect the young seedlings from direct solar radiation. The seedlings were thinned to avoid overcrowding. The seedlings were watered until they reached transplanting stage. The seeds were nursed in June and transplanted in July.

The seedlings were transplanted when they were about two weeks old. The seedlings were watered before uprooting for transplanting to soften the soil for easy lifting.

Field preparation

The field was prepared by clearing weeds and debris. A land measuring 15 m by 40 m was ploughed and arrowed into ridges to allow proper movement of the plant root. Each plot was lined and pegged.

Treatment application

All the treatments were applied two weeks before planting at the rates of manure 3 t/ha. This was done by using ring method after pulverizing them. Meanwhile, no treatment was applied to the control.

Collection of soil samples for physicochemical analysis
Prior to planting, composite samples were taken from each plot at a depth of 0 to 15 cm to determine the physio-chemical properties of the soil.

The samples were bulked and air-dried for routine analysis). Organic matter (O.M) was determined by Walkley-Black dichromate digestion method (Nelson and Sommers, 1982), and total soil nitrogen was determined by the kjeldahl method (Bremner and Mulvancy, 1982). Available P was determined by Bray-1 method (Murphy and Riley, 1962). Exchangeable K^+, Ca^{2+} and Mg^{2+} were extracted using ammonium acetate. Potassium was determined using the flame photo meter and Ca and Mg by EDTA titration. The soil pH in 0.01 M $CaCl_2$ was determined using glass electrode.

Cultural practices

The plot was manually cleared with hoes three times to prevent weeds from competing with the crop for nutrients, sunlight and water. The plants were also sprayed with insecticide (cypermetrin) to prevent insect attack.

Data collected

For the growth parameters, plant height (cm) was measured by tape rule, stem diameter (mm) was determined by vernier caliper, number of branches, number of leaves and number of fruits was done by direct counting. The yield parameters evaluated include total weight of the matured garden egg (kg) and this was done with weighing balance. The percentage fat (% fat) was determined using Soxhlet extraction method and calculated as follows:

$$\%FAT = \frac{w_2 - w_3}{w_2 - w_1} \times 100 \qquad (1)$$

From the dried sample, 2 g was weighed and digested for nitrogen determination using Kjeldahl method. The nitrogen determined was then multiplied by a constant (6.25) to determine the protein content. For ash determination, crucibles were dried over the hot plate and cooled in the desiccator for about one hour. The crucibles were weighed (W_1). Thereafter, 1 gram of each sample was weighed inside the crucibles and weighed (W_2). The samples were pre ashed with Bunsen burner flames until sample became charred. The crucible was then transferred to the muffled furnace set at 550°C. Ashing continued until a light grey or white ash was obtained. The crucibles were then cooled in the dessicator and weighed (W_3).

All data collected were subjected to analysis of variance (ANOVA) to test treatment effects for significance using SPSS version 21 statistical package. Significant means were separated using Tukey test at 0.05 level of probability.

RESULTS

The data obtained on the height, stem girth, number of branches, and number of leaves of garden egg is presented in Table 1. Result revealed that Garden egg height increased appreciably throughout the experiment across treatments. Garden eggs in plots treated with poultry manure had the highest height (74.33 cm) while garden eggs in plots treated with control had the least height (43.76 cm) at 8 weeks after treatment application (WATA). However, there were no significant differences among the manure treatments. Also, all plants that were treated with manure were significantly better than control.

Result also showed that the stem girth of manure treated plants were significantly better than the control ($p > 0.05$). Similarly, there were no significant differences among manure treatments but they were significantly better than the control in respect to number of leaves and number of branches.

The effects of the manure types on fruit yield of garden egg are presented in Table 2. In respect to number of fruits/plant, there were no significant differences among treatments where manure was applied (Poultry manure/95.75, Compost/91.33, FertiPlus/90.58, Sunshine/101.08, Cow dung/102.58 and Cow dung/89.82) however, all the manure treatments were significantly better the control. Likewise, all the manure treatments were significantly better than control in respect to fruit weight, and fruit yield/ha.

The effects of the manure types on proximate composition (Moisture content, ash, fat, crude protein, crude fribre and carbohydrate) of the garden egg are presented in Table 3. The proximate composition of the garden egg differed significantly ($p < 0.05$) across treatments. Plots treated with cow dung recorded the highest value of moisture content (11.22%), crude protein (10.72) and crude fibre(0.19) which were significantly better than other treatments. Meanwhile, the controlplots recorded the lowest values of 6.42%, 10.72 and 0.19 for moisture content, crude protein and crude fibre respectively. Plots treated with FertiPlus manure recorded the most significant value for Ash (9.36%) while the least value (4.78%) was found in the control. The highest value of fat (4.99%) was recorded in plots treated with sunshine manure and which was significantly better than other treatments. Also, all manure treatments were significantly better than control which had the least value of fat (1.49%). Similarly, the highest value of carbohydrate (65.92%) was recorded in plots treated with sunshine manure while the lowest value of (58.21%) was found in plots treated with fertiplus.

Table 1: Effects of manure types on growth parameters of garden egg

Manure types	Weeks after treatment application		
	4	6	8
	Plant height (cm)		
Poultry	27.75[a]	52.17[a]	74.33[a]
Compost	27.50[a]	52.67[a]	72.42[a]
Ferti plus	17.25[a]	33.33[ab]	66.67[a]
Sunshine	25.75[a]	48.33[a]	74.00[a]
Cow dung	20.42[a]	42.42[a]	67.08[a]
Control	13.32[b]	23.98[c]	43.76[b]
	Stem girth (mm)		
Poultry	9.04[a]	14.04[a]	17.50[a]
Compost	8.00[ab]	13.25[a]	16.72[a]
Ferti plus	7.86[ab]	12.91[a]	16.04[a]
Sunshine	9.05[a]	13.86[a]	17.23[a]
Cow dung	8.83[ab]	12.34[a]	15.87[a]
Control	6.25[c]	9.29[b]	10.90[b]
	Number of branches		
Poultry	4.58[a]	5.08[a]	7.25[ab]
Compost	4.25[a]	4.50[a]	8.17[a]
Ferti plus	4.58[a]	4.58[a]	5.83[b]
Sunshine	4.67[a]	4.83[a]	8.75[a]
Cow dung	4.75[a]	4.50[a]	7.17[ab]
Control	2.86[b]	3.18[b]	5.34[c]
	Number of leaves		
Poultry	25.33[a]	45.25[a]	66.75a
Compost	23.75[a]	43.25[a]	65.50[a]
Ferti plus	25.83[a]	37.58[a]	55.68[a]
Sunshine	28.00[a]	42.33[a]	67.25[a]
Cow dung	24.33[a]	36.08[a]	60.25[a]
Control	21.25[b]	29.80[b]	46.91[b]

Table 2: Effect of manure types and rates on yield of garden eggs

Treatments	Number of Fruits plant^{-1}	Fruit weight plant^{-1}(g)	Fruit yield (kg ha^{-1})	Fruit yield (t ha^{-1})
Poultry	95.75[a]	2341.50[a]	78049[a]	78.05[a]
Compost	91.33[a]	2289.92[a]	76330[a]	76.33[a]
Ferti plus	90.58[a]	2414.92[a]	80494[a]	80.50[a]
Sunshine	101.08[a]	2514.92[a]	83830[a]	83.83[a]
Cow dung	102.58[a]	2773.92[a]	92463[a]	92.46[a]
Control	89.82[b]	2108.32[b]	63052[b]	53.27[b]

Table 3: Effects of manure types and rates on the proximate composition of garden egg

Manure types	Moisture content (%)	Ash (%)	Fat (%)	Crude Protein (%)	Crude Fibre (%)	Carbohydrate (%)
Poultry	10.87^{b}	7.57^{b}	3.52^{d}	13.91^{b}	0.31^{b}	63.80^{d}
Compost	9.68^{e}	6.74^{d}	4.92^{b}	12.69^{e}	0.22^{c}	65.75^{b}
Ferti Plus	10.54^{c}	9.36^{a}	4.44^{c}	13.13^{c}	0.23^{c}	62.30^{e}
Sunshine	9.99^{d}	6.14^{e}	4.99^{a}	12.84^{d}	0.17^{d}	65.92^{a}
Cow Dung	11.22^{a}	6.83^{c}	3.37^{e}	14.09^{a}	0.40^{a}	64.09^{c}
Control	6.42^{f}	4.78^{f}	1.49^{f}	10.72^{f}	0.19^{e}	58.21^{f}

The physico-chemical properties of the experimental field are presented in table 4. Results showed that the soil had a pH of 6.20 which was fairly acidic. The soil also contained 1.98 Organic matter and 17.86 Exchangeable cations. Various nutrients found in moderate proportions include Nitrogen (0.86), carbon (0.49), Phosphorus (22.64), potassium (0.33), calcium (3.10) and Magnesium (2.00). Result also revealed that the soil contained sand (51.880 g/kg), silt (18.854 g/kg) and clay (30.070 g/kg).

Table 4: Initial physicochemical properties of the soil

Parameters determined	Value
pH	6.20
Organic matter (mg kg^{-1})	1.98
Exchangeable cations (cmol/kg)	17.86
Nitrogen (mg kg^{-1})	0.86
Organic carbon (mg kg^{-1})	0.49
Phosphorus (mg kg^{-1})	22.64
Potassium (mg kg^{-1})	0.33
Calcium (mg kg^{-1})	3.10
Magnessium(mg kg^{-1})	2.00
Sand	51.88
Silt	18.85
Clay	30.07

Effects of the manure types on soil chemical properties are presented in Table 5. Result revealed there were significant differences ($p < 0.05$) across treatments used. Plots treated with poultry manure recorded the highest values which was significantly better than other treatments for total nitrogen, calcium, potassium, phosphorus and sodium (0.15, 0.28, 0.20, 13.31 and 0.15) respectively. However, all the manure treatments were not significantly different from each other in the final total magnesium but significantly better the control (0.98). The highest value of total organic matter (TOM) was recorded in FertiPlus (2.38) while the least value was recorded in plots treated with poultry manure (1.11). Result also showed that all manure treatments were significantly better than the control. Plots treated with sunshine manure (12.78) recorded the highest value of Exchangeable cation (EC) and the least was recorded in the control (8.68). Result also showed that plots treated with poultry were significantly better than other treatments in respect to soil pH (6.37) while other treatments were not significantly different from each other.

Table 5: Final physicochemical properties of the soil

Manure types	TN (g kg^{-1})	Ca (mg kg^{-1})	K (mg kg^{-1})	Mg (mg kg^{-1})	P (mg kg^{-1})	Na (mg kg^{-1})	TOM (g kg^{-1})	EC (cmol/kg)	pH
Poultry	0.15^{a}	0.28^{a}	0.20^{a}	2.28^{a}	13.31^{a}	0.15^{a}	1.84^{e}	10.12^{e}	6.37^{a}
Compost	0.13^{bc}	0.25^{b}	0.17^{d}	2.01^{a}	11.96^{c}	0.13^{b}	2.20^{b}	12.14^{c}	6.02^{bc}
Ferti Plus	0.13^{bc}	0.23^{d}	0.17^{c}	2.78^{a}	11.98^{c}	0.12^{c}	2.38^{a}	12.50^{b}	5.93^{c}
Sunshine	0.12^{cd}	0.24^{c}	0.19^{b}	1.82^{a}	12.77^{b}	0.11^{d}	1.94^{d}	12.78^{a}	6.03b^{c}
Cow Dung	0.11^{d}	0.22^{d}	0.14^{e}	1.99^{a}	10.63^{d}	0.11^{d}	2.04^{c}	11.87^{d}	6.01^{bc}
Control	0.08^{e}	0.14^{e}	0.10^{f}	0.98b	6.50e	0.08^{e}	1.11^{f}	8.68^{f}	6.01^{bc}

Means followed by the same letter in the same column for each parameter are not significantly different from each other at 5% level of probability by Tukey test

DISCUSSION

The application of organic manure has been observed to consistently increase the growth and yields of horticultural crops. Unlike the application of inorganic fertilizers that have some environmental and health risk, organic manures pose no threat while also increasing the soil fertility. In this particular study, plants that were treated with organic manures had better growth and yield. Poultry manure had positive effects on growth and yield of garden egg and this could be attributed to the fact that poultry manure contained essential nutrient elements associated with high photosynthetic activities and thus promotes roots and vegetative growth (Mpanga et al., 2021; John *et al.*, 2004).

All the treatments had a greater number of leaves than the control, this could also be the reason they had higher significant growth and yield rate. According to Dauda *et al.* (2008), who worked on melon, increase in the number of leaves means plants are more able to receive greater amount of radiation which in turn increases the photosynthetic rate of the plant, resulting into greater quantity of fruits.The higher number of fruits and weight obtained from the application of cow dung is in accordance with the study of Mohammad *et al* (2010), where application of cow rates of nutrients increased the average fruit weight and volume. The low performance of the control treatment were as a result of nutrient stress by the plants which agrees with the findings of Aujla *et al*., (2007), and Akanbi *et al*. (2007) where similar reports were also obtained.

The highest crude protein content recorded in plots treated with cow dung might be because organic materials are more readily available in cow dung since manures have to be slowly decomposed and organic nutrients mineralized. Nutrients contained in manure are released more slowly and are stored for a longer time in the soil ensuring longer residual effects, improved root development and higher crop yield. This was also observed by Aluko and Oyedele (2005), who reported that slow decomposition of organic material releases the nutrients over a long time during the crop growth period and also improves soil properties. The soils treated with cow dung also retained higher moisture content than other treatments and control. These suggest that cow dung has the ability to increase soil moisture content. The improvement in soil moisture content could also be attributed to increase in organic matter content as a result of cow manure application. Organic manure is usually applied at higher rates, relative to inorganic fertilizers. Organic manure, thereby improves soil fertility by activating soil microbial biomass.

CONCLUSION AND RECOMMENDATION

The results of this study showed that application of manure had significant effects on *Solanum melongena* growth, yield and quality. Therefore, organic manure is recommended in garden egg production because it is cheaper, easily available, and also booster of soil fertility.

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Author Contributions

DA conceived the research. DA and OPparticipated in the experimental design and coordination. DA collected soil samples. DA and OA analyzed the data and prepared the tables. EC and MJ provided technical assistance. OP supervised the research. DA and OA wrote the draft manuscript. DA, OA, EC and MJ proofread and finalized the anuscript. All authors read and approved the final version.

Ethics Committee Approval

N/A.

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