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EFFECT OF POULTRY MANURE AND NPK FERTILIZER ON GROWTH AND YIELD OF EGGPLANT (*Solanum melongena)*

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ABSTRACT

A field study was conducted during the farming season of 2011 at Students Research and Demonstration Farm of Kogi State University to assess the effect of organic and inorganic fertilizers on growth and yield of eggplant (Solanum melongena). A Randomized Complete Block Design was used with three treatments with control and three replications. The treatments were: T_1 = poultry manure (5 t/ha) + NPK 15:15:15 (125 kg/ha), T_2 = NPK (250 kg/ha), T_3 = poultry manure (9 t/ha) and control. The result showed significant difference ($p<0.05$) in all the parameters measured. The fruit yield was high in the combined application of organic and inorganic fertilizer and significantly different from either sole organic or inorganic nutrient sources or control. Among all the treatments, application of 5 t/ha of poultry manure + 125 kg/ha NPK produced the best response.

Keywords: Poultry manure, NPK, Eggplant, Growth and yield

INTRODUCTION

Eggplant (*Solanum melongena)* is one of the major vegetables grown in West Africa. The local types as well as the aubergine or exotic types are cultivated but the local types are common in West African countries (Norman, 1992). The crop is known by several names like aubergine and egg plant in Europe and United States, “bringers” in South East Asia and it is only known as garden eggs in West Africa (Obeng-Ofori *et al.,* 2007). The crop is grown for either the immature fruits or leaves depending on the locality. The immature fruits are either eaten raw or cooked (Prota, 2004). The crop is cultivated in tropical Africa, Asia and America and throughout the tropical and subtropical areas (Tindall, 1992).

The eggplant is an important vegetable due to its nutrient value. It is well adapted to the tropical climate and its growth is affected by nitrogen and phosphorus availability (Rao and Subramanian, 1994). Nitrogen deficiency affects growth of new leaves and stem and phosphorus deficiency affects fruit formation.

Nitrogen is very important for plant growth because it is part of protein and nucleic acid which are basic components of plant protoplasm and chlorophyll which are indispensable for photosynthesis. Phosphorus is also an essential element of plant structure as well as component of energy compound like Adenosine Tri-Phosphate (Marschner, 1995). Oversupply of nitrogen has negative impact on the quality of the fruit. Both the colour and flavour of fruits may be poor and sugar and vitamin contents of certain vegetables are adversely affected by excessive nitrogen. Fertilizers have been established to be important in *Solanum* species cultivated (Olaniyan and Nwachukwu, 2003). While nitrogen is important in vegetative development, phosphorus is needed to stimulate flowering and fruit formation and potassium is for seed setting. Compound NPK fertilizer is therefore needed for good crop yield in *Solanum* species (Ojo and Olufolaji, 1999).

In order to obtain high yield of eggplant there is the need to augment the nutrient status of the soil to meet the crop’s requirement and thereby maintaining the fertility status of the soil. One of the ways of increasing the nutrient status is by boosting the soil nutrient content either with the use of organic materials such as poultry manure, other animal wastes and use of compost with or without inorganic fertilizers (Dauda *et al.,* 2008). Poultry manure is relatively resistant to microbial degradation. However, 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 but its availability remains an important issue due to its bulky nature, while inorganic fertilizer is no longer within the reach of resource-poor farmers due to its high cost (Rahman, 2000). However, Jahn *et al.* (2004) have advocated for an integrated use of organic manure and inorganic fertilizers for supply of adequate quantities of plant nutrients required to sustain maximum crop productivity and profitability, while minimizing environmental impact from nutrient use. According to Said (1997), the use of

manure enhances soil productivity, increases the soil organic carbon content, enhances the activities of soil micro-organisms, improve soil crumb structure and the nutrient status of the soil as well as yield. Compost plays a vital role in improving soil properties and sustaining nutrients status.

The study was carried out to explore the practicality of extensive use of organic manure on the farm. The reason is the soaring cost of inorganic fertilizer; it is increasingly difficult to purchase fertilizer in the required quantity for use on the farm by the local farmers. Also, farmers have in time past experienced decline in crop yield over time due to the use and over-use of chemical fertilizer to a point of high accumulation that additional use makes no differences in yield. This therefore gives rise to the need to explore a cost effective means of fertilization because most farmers are mostly peasant who find it difficult to purchase the inorganic chemicals at the present non-subsidized rates. In addition, the quest for organic food is on the increase worldwide.

MATERIALS AND METHODS

Study area

The study was carried out at the Kogi State University demonstration farm, Anyigba, Kogi State. (lat. 7^{O} 06'N and long. 6^{O} 43'E) located within the South Eastern Guinea Savanna agro-ecology of Nigeria (Kowal and Knabe, 1972).

The site lies within the warm humid climate of the middle belt zone of Nigeria with clear, distinctive dry and wet season. The average temperature is 27^{O}C uniformly high throughout the year. Annual temperature does not exceed 38^{O}C and mean annual rainfall is 1260 mm with peaks in the month of July and September.

Experimental Design

The study was carried out during the wet cropping season of 2011.The design was Randomized Complete Block Design with three replicates and three treatments with control. The treatments were T_1 = 5 t/ha Poultry manure + 125 kg/ha NPK, T_2 = 250 kg/ha NPK, T_3 = 9 t/ha Poultry manure and control.

Land Preparation

The land was ploughed, harrowed, pegged and laid out. Blocking was done across the slope to keep applied nutrients from being washed into other plots. Each plot size was 2 m x 2 m. The total number of plots in each replicate was 3, giving a total of 12 plots. The inter block and plot spacing was 1 m and 50 cm respectively. The size of the entire experimental area was 11 m × 7 m. Composite soil samples were collected prior to transplanting with soil auger at a depth of 0-15 cm, air-dried, crushed and sieved with 2 mm mesh and then taken to the laboratory for physical and chemical analyses. Poultry manure was incorporated into the soil according to treatment two weeks before transplanting in order to equilibrate properly with the soil. Then seedlings were transplanted on the flat fortified beds at about 6 cm depth into the soil.

Nursery practices

A nursery bed measuring 2 m x 1.2 m was prepared. The seeds were sown in row of 10 cm apart. The seed beds were watered and covered with mulch after sowing. After germination the mulch was removed and shade was erected to protect the young seedlings against direct sunlight. The seedlings were watered until transplanted.

Physico-Chemical Analysis of Soil

Soil particle size analysis was done according to Bouyoucos (1962). Organic carbon content was determined using Walkey-Black (1934) chromic acid digestion procedure. The organic matter content was determined using Anderson and Ingram (1993) method. Soil pH was determined electronically using glass electrode pH meter (Mclean, 1982). Available phosphorus was determined by Bray and Kurtz (1945) extraction procedure. Exchangeable bases (Ca, Mg, Na, K) were extracted in NH_4OAC buffered at pH 7.0 (Thomas, 1982). Cation exchange capacity (CEC) was determined by summation of exchangeable bases or cations. The N content of soil and plant tissue samples was determined after digestion of the samples with conc. H_2SO_4 in the presence of Kjeldhal catalyst (Bremner and Mulvancy, 1982). The exchangeable acidity were extracted with KCl (Thomas, 1982) and determined by titration with 0.05, NaOH using Phenolphthalein as indicator.

Chemical Analysis of Poultry Manure

The nutrients were extracted by dry ashing method described by Piper (1944). Air-dried and ground poultry manure samples were sieved through 2 mm sieve and ignited at 45^{0}C for 2 hours. The ash was extracted with HCl. Potassium, total nitrogen, available phosphorus, calcium, magnesium, sodium and organic matter were determined following the procedures that was outlined in the soil analysis section.

Statistical Analysis

The data collected on various parameters were subjected to analysis using ANOVA. The means were separated using Fisher's Least Significant Difference (F-LSD) at 5% probability level.

RESULTS AND DISCUSSIONS

Soil Analysis

The various physical and chemical properties of the soil used are shown in Table 1. The pH of the soil as obtained from the composite sample was 5.9. This falls within the moderate acid range (5.6 – 6.0) of pH which is optimum for most crops (the optimum pH range for most plants is between 6 and 7.5). The percentage organic matter content was 0.16.

The nitrogen content of the soil used was 0.08% which falls within the low range of Soil Fertility Classes for Nigerian soils (Sobulo and Adepetu, 1987; Adepetu, 1990). This result is within the range (0.05 – 1.64%) for tropical soils (Birch and Friend, 1956). The concentration of available phosphorus in the soil was 33.96 ppm. This falls within the high range of Soil Fertility Classes for Nigerian soils (Sobulo and Adepetu, 1987; Adepetu, 1990).

The result from the determination of exchangeable cations showed that K concentration was 2.72 Cmol/kg soil, Mg 3.62 Cmol/kg soil, Ca 5.40 Cmol/kg soil and Na 1.48 Cmol/kg soil.

The results of the exchangeable base and acidic were 13.22 and 0.64 respectively. This value reflects the moderate base/acid values for some soils. The values of CEC and percentage base saturation were 13.86 and 95.38 respectively.

The result of Mechanical Analysis (particle size distribution) reveals that percentages of sand is 77.65%, clay 19.07% and silt 3.28%. The textural class of the soil is Sandy Clay Loam.

Table 1: Some physico- chemical characteristics of the soil used in this study

Properties	Value determined
pH (H_2O)	5.9
Organic matter (%)	0.16
Available phosphorus (ppm)	33.96
Total Nitrogen (%)	0.08
Exchangeable cation (Cmol/kg)	
K^+	2.72
Na^+	1.48
Ca^{++}	5.40
Mg^{++}	3.62
Exchangeable base	13.22
Exchangeable acid	0.64
CEC	13.86
Percentage base saturation	95.38
Particle size (%)	
Sand	77.65
Silt	3.28
Clay	19.07
Textural class	Sandy Clay Loam

Table 2: Some chemical composition of poultry manure used in the study

Chemical composition	Value (%)
Nitrogen	4.30
Available phosphorus	1.45
Potassium	2.11
Calcium	4.92
Magnesium	0.39
Sodium	0.31
Organic carbon	45.23

The result presented in Table 3 showed significant difference at 2, 3, 4, 5 and 6 weeks after transplanting (WATP). In all the treatments, plant height gradually increased from 1 to 6 WATP. However the combined application of poultry manure and NPK gave the highest heights of plant; 7.72, 12.13, 15.13, 51.40, 72.20 and 93.20 cm at 1, 2, 3, 4, 5 and 6 WATP respectively. The Plant heights for the first week did not show significant difference. This shows that the crop did not benefit from the soil amendments in the first week. However, from the second week, the treatment that received poultry manure and NPK fertilizer significantly grew faster than other treatments. This indicates that poultry manure in combination with inorganic fertilizer was able to release adequate nutrients for the growth of the eggplant. Jahn *et al.* (2004) reported that poultry manure contains essential nutrient elements associated with high photosynthetic activities and thus promote roots and vegetative growth.

The result presented in Table 4 showed significant difference at 2, 3, 4, 5 and 6 WATP. In all the treatments, number of leaves gradually increased from 1 to 6 WATP. However the combined application of poultry manure and NPK produced the highest number of leaves; 6.00, 11.00, 22.00, 34.00, 53.33 and 74.00 cm at 1, 2, 3, 4, 5 and 6 WATP respectively. The number of leaves for the first week did not show significant difference. This shows

that the crop did not benefit from the soil amendments in the first week. However, from the second week, the treatment that received poultry manure and NPK fertilizer significantly increased in vegetative growth than other treatments. This indicates that poultry manure in combination with inorganic fertilizer was able to release adequate nutrients for the growth of the eggplant.

Table 3: Effect of organic and inorganic fertilizer on height of eggplant

Treatment	Week after transplanting (cm)					
	1	2	3	4	5	6
T_1	7.72	12.13	15.13	51.40	72.20	93.20
T_2	7.13	10.07	12.13	31.97	49.50	55.10
T_3	7.47	10.38	13.13	41.43	51.20	60.57
Control	6.98	9.20	10.13	19.47	32.73	41.53
Average	7.33	10.45	12.63	36.07	51.41	62.60
LSD	0.79ns	0.86*	0.99*	4.95*	3.84*	6.27*
CV (%)	4	10	14	33	27	30

* = significant, ns = not significant

Table 4: Effect of organic and inorganic fertilizer on number of leaves of eggplant

Treatment	Week after transplanting (cm)					
	1	2	3	4	5	6
T_1	6.00	11.00	22.00	34.00	53.33	74.00
T_2	5.42	6.33	11.67	22.33	31.67	43.67
T_3	5.13	6.00	12.00	22.00	37.00	60.57
Control	5.07	5.67	8.33	12.33	21.00	35.00
Average	5.41	7.25	13.50	22.67	35.75	53.31
LSD	0.94ns	0.84*	0.98*	2.23*	4.01*	5.98*
CV (%)	7	30	38	34	33	28

* = significant, ns = not significant

The result presented in Table 5 showed that the yield of eggplant increased significantly with the application of poultry manure and NPK. A significant interaction ($P<0.05$) between organic manure and inorganic fertilizer had effect on the fruit number, length, diameter and weight. The significantly high yield obtained in the study could be attributed to the nutrient content of poultry manure which was translated into high vegetative growth that gave rise to high photosynthesis which culminated into high yield (Jahn *et al.,* 2004).

Table 5: Effect of organic and inorganic fertilizer on average yield and yield component of eggplant

Treatment	Average number of fruit	Average length of fruit (cm)	Average diameter of fruit (cm)	Average weight of fruit (kg)
T_1	12.42	9.32	8.29	14.53
T_2	7.84	8.46	7.33	8.75
T_3	8.53	8.97	7.52	10.78
Control	3.87	6.42	5.98	5.49
Average	8.17	8.29	7.28	9.89
LSD	1.04ns	0.99*	1.02*	1.23*
CV (%)	37	14	11	33

* = significant, ns = not significant

In general, organic manure was sufficient to encourage the capability of plants to produce high total yield and enhanced the fruit characters as compared to plants treated with inorganic fertilizer alone due to its high rate of N and P as shown in table (2), this in turn led to increased vegetative growth and consequently favoured carbohydrate build up which resulted in in more plant growth characters and yield components of eggplant. Chindo and Khan (1986) reported that addition of suitable organic manure in the soil improves the soil structure and hence, encourage the plant good root and lead to higher yields. This could be attributed to the fact that the nutrients in the organic manure are released gradually through the process of mineralization (Bationo *et al.,* 2004) maintaining optimal soil levels over prolonged periods of time. Some of the organic substances released during the mineralization may act as chelates that help in the absorption of iron and other micro-nutrients (Schlecht *et al.,* 2006).

The superiority of poultry manure plus NPK, as compared to other treatments, may be due to increased uptake of N and P which resulted in increased plant weight due to increased number of leaves and branches. The improved plant growth led to better carbohydrate build up which increased the plant fruit yield and their quality components. In this concern, Agbede *et al.* (2008) reported similar results and explained that addition of suitable organic manure in the soil improves the soil physical and chemical properties which encourage better root development, increased nutrient uptake and water holding capacity which leads to higher fruit yield and better fruit quality.

The higher yields from organic manure plus inorganic fertilizer treatment than sole inorganic fertilizer treatment is an indication that integrated use or organic and inorganic nutrient sources of N is advantageous over the use of inorganic fertilizer alone. Earlier studies demonstrated that use of organics could enhance efficiency of chemical fertilizer (Dudal and Roy, 1995). Other researchers have observed higher eggplant yields through application of high quality organic inputs in combination with inorganic fertilizer as compared to sole application of inorganic fertilizers (Esilaba *et al.,* 2005).

Integration of organic and inorganic nutrient inputs could therefore be considered as a better option in increasing fertilizer use efficiency and providing a more balanced supply of nutrients.

CONCLUSION

The study showed that both organic manure and inorganic fertilizer have their own roles to play in soil fertility management but none can solely supply all the nutrients and other conditions of growth for producing eggplant. The study suggested that for the cultivation of eggplant in the area under study, a combination of poultry manure and NPK may be use. Also considering the economic implication in sourcing inorganic fertilizer and the effect on the environment, decreasing rate of application of inorganic fertilizer plus increasing rate of poultry manure is recommended for eggplant production. The study also suggested that more experiment should be done on higher rates of poultry manure and lower rates of NPK fertilizer on the crop.

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