Fruit Yield Responses of Eggplant *(Solanum melongena)* to Single and Combined Applications of Organic and Inorganic Fertilizers

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Abstract

A study was carried out in the experimental farm of the Department of Crop Science, University of Nigeria, Nsukka in the period of September 2003. and February 2004 to determine the effect of different rates of poultry manure and NPK 15.15:15 fertilizer and their interaction on fruit yield of Solanum melongena. The study was repeated in the months of July to November, 2007, in the same area. Four rates of poultry manure 0, 5, 10 and 15 tons/ha and four rates of NPK: 15:15:15 fertilizer, 0, 200, 350 and 400kg/ha and their combinations were tested in a factorial in Randomized Completely Block Design (RCBD) experiment. The result revealed that application of poultry manure significantly increase fruit yield in the crop. Fruit yield/ha increased by 54.03% 90.65% and 145.97% as manure was increased from 0 ton/ha to 5, 10 and 15 tons/ha, respectively, in 2004. In the 2007 experiment it increased by 147.98%, 166.67% and 176.94 as manure was increased from 0 ton/ha to 5, 10 and 15 tons/ha, respectively. Fertilizer application also significantly increased fruit yield. Fruit yield increased by 23.86%, 29. 51 % and 30.78% in 2004 and by 129.28% 157.4% and 144.61% in 2007 as NPK 15:15:15 application was increased from Okg/ha to 200, 350 and 400kg/ha, respectively. Poultry manure by NPK 15: 15: 15 interaction was not statistically significant in the plant yield attributes studied, however, the combination of 15ton/ha poultry manure and 350kg/ha NPK 15:15:15 fertilizer gave the highest fruit yield/ha in both years

Keywords: Poultry manure, NPK 15:15:15 fertilizer

Introduction

The garden eggs *Solanum melongena* is a member of the Solanaceae family (Schipper, 2000). The name Solanum has, however, been used to represent many species of the genus *Solanum.*

In Nigeria, the edible Solanum species are commonly known as anara" (Igbo) and Ikan (Yoruba), (Schipper, 2000). They are eaten in various forms. The leave of some varieties are harvested and either eaten fresh or used in preparing soup and stew. The fruits are eaten green and are popularly used in serving guests. In some species, the fruits are boiled and later prepared into sauce for eating yam. This crop has assumed considerable popularity among the people of the country so much that it is produced all year round and is consumed throughout the year. Considering the importance of this crop in the life of the people, it has become necessary to carry out research on ways of increasing its production in order to meet up with increased demand.

One of the major problems limiting crop production is soil fertility. This has so far been checked by the application of plant nutrients to the soil by applying fertilizer either the organic or inorganic types. Organic fertilizers apart from releasing nutrients to the soil also improve its physical properties, which enhance plant growth, development and quality (Akanbi *et al.,* 2007). However, release of nutrient is slow in organic fertilizer but more lasting compared to the faster release of inorganic fertilizers, which are often lost rapidly by leaching in porous soil and heavy rainfall areas. Frequent and high rate of inorganic fertilizer use has been associated with some environmental pollution. Also these important production inputs have recently become expensive and scarce in many countries. It, therefore, became necessary to carry out studies on ways of reducing the dependence on mineral fertilizers. Research work in other crops revealed that best yields were obtained by appropriate combination of organic and inorganic fertilizers (Magda and Asman, 2009; Marinice *et at* 2008; Naik and Ballal, 1968; Magadoff and Amadon, 1980; Mbagwu and Ekwealor, 1990). The objective of this study, therefore, was to determine the rates of poultry manure and NPK 15: 15: 15 fertilizer either use singly or in combination that will give optimum fruit yield of *Solanum melongena*

Materials and Methods

The experiment was conducted in the Department of Crop Science Teaching and Research farm; University of Nigeria, Nsukka between September 2003 and February 2004 and was repeated in the same area but in different plots between June and December 2007. The site is located on latitude 06^0 25^1 North; longitude $07^0 24^1$ East and altitude of 447.2m above sea level.

The solanum seeds used (from the popular Ngwa type) were obtained from the seed store of the Department of Crop Science, University of Nigeria, Nsukka. They were treated with Apron plus powder (metalaxy. 10%, carboxin 6% and furathcarb 34%) and broadcast in basket nurseries. The soil medium was mixed in the ratio of 3:2:1 of top soil, poultry manure and river sand. The nursery baskets were placed under shade and watered adequately.

The experimental site was ploughed and harrowed and later prepared into beds. Soil samples at the depth of 15cm were collected from several points in the site, bulked together and samples taken to the laboratory for analysis. The experiments were laid out in a factorial in Randomized Complete Block Design (RCBD) in three replications. The factors were poultry manure and NPK 15:15:15 fertilizer formulation. The rates were 0, 5, 10, and 15 tons/ha poultry manure and 0, 200, 350 and 400kg/ha of NPK 15:15:15 fertilizer. This resulted to a 4 x 4 factorial experiment with 16 treatment combinations. Each of the three blocks was divided into sixteen plots each measuring 3m x 1m. Distance between plots was one metre. The poultry manure treatments were applied to their respective plots and worked into the soil three days before transplanting. The seedlings were transplanted to the field at the third week after emergence in the nursery. The plots were also irrigated uniformly using watering can during the dry period of 2004 experiment. Data collected include number of fruits/plant; fruit yield plant (g), number of fruit/ha, fruit yield/ha (ton/ha) and average fruit weight (g). The data were analysed according to the procedures outlined by Steel and Torrie (1980) for factorial experiments. Separation of means for statistical significance was by the F-LSD method as described by Obi (2001).

Results

The results of the soil analysis and weather record during the periods of the experiments are shown in Table 1 and 2. The result of the F-LSD test ($P < 0.05$) presented in Table 3 showed a consistent increase in the yield attribute as poultry manure rate was increased from 0 to 15tons/ha. The only exception was on average fruit weight where the application of 15tonha of poultry produced lower value than the application of 5 and 10 tons/ha rates.

Table 1: Physical and chemical properties of the soil of the experimental site before planting in the first and second experiments

	2003	2007
Physical Properties (%)		
Course sand	40	39
Fine sand	28	26
Clay	24	22
Silt	12	13
Chemical Properties		
PH I in Water	4.80	4.40
PH in KCL	4.00	3.70
Organic matter%	1.10	1.55
Total nitrogen%	0.06	0.42
Total carbon%	0.64	0.90
Available P (ppm)	2.60	8.80
Available Na (meq/100g)	0.10	0.10
Available K (meq/100)	0.07	0.12
Exchangeable Ca (meq/100)	1.60	0.71
Exchangeable Mg (meq/100)	0.90	1.14
Exchangeable A1 (meq/100)	0.80	2.20
Cation exchange capacity (meq/100)	7.00	18.40

There were however statistically non significant difference between the effects of 5ton/ha and 10ton/ha, and between 10ton/ha and 15ton/ha rates of poultry manure on number of fruits/plant, fruit yield/plant, fruit yield/ha and average fruit weight in the 2007 experiment. Application of NPK 15:15:15 fertilizer was also found to cause significant increase in fruit yield (Table 4). A consistent increase in fruit yield was recorded as the fertilizer rate was increased from 0 to 400g/ha in the 2004 experiment. However, in 2007 steady yield increase was observed as fertilizer increase from 0 to 350kg/ha. Further increase of fertilizer rate to 400kg/ha caused a decline in all the fruit yield attributes. The differences between the effect of 350kg/ha and 400kg/ha rates of fertilizer on number of fruits/plant, fruit yield plant, fruit yield/ha and average fruit weight (g) were statistically non significant in both 2004 and 2007 experiments.

The mean effect of the treatment combinations shown in Table 5 indicated that the application of 15ton/ha poultry manure with 350kg/ha fertilizer produced the highest performance in all the yield attributes with the exception of average fruit weight in 2004 experiment. In that year the highest average fruit yield was obtained from the combination of 15ton/ha poultry manure and 200kg/ha fertilizer. In the second experiment (2007) highest fruit yield/plant, fruit yield/ha and average fruit weight were obtained from plant that received a combination of 15ton/ha poultry manure and 350kg/ha NPK fertilizer (Table 5). This did not differ statistically from the values obtained from combining 10ton of poultry manure with 350kg fertilizer, and combining 10ton poultry manure and 400kg fertilizer. The highest yield was also not statistically different from the yield obtained from the combination of 5ton poultry manure and 400kg fertilizer and combination of 5ton poultry manure with 250kg fertilizer in 2007 experiment. Combined application of 10ton/ha poultry manure and 350kg/ha NPK fertilizer produced the highest number of fruits/plant and number of fruits/ha.

Discussion

The soil analysis in both years' experiments revealed that the soil is sandy clay loam and have low pH. From the recommendation of Ibedu *et al* (1988) the soils were low in total nitrogen, organic matter content, available K and P. This implies low soil fertility for both areas. The weather record in the periods of the first experiment indicated adequate rainfall in the months of September and October 2003. The proceeding months, November, December 2003 and January and February 2004, witnessed low rainfall. In the second experiment, however, adequate rainfall was maintained in the months of August, September and October and this coincided with the period of peak fruit production. This appeared to be responsible for the higher fruit yield recorded in the second (2007) experiment. The prevalent temperatures at both periods fall within the range required by the crop (Schipper, 2000).

Table 2: Physical and chemical properties of the soil of the experimental site before planting in the first and second experiments

Year	2003				2004				2007			
Month	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Rainfall amount (mm)	315.47	249.67	19.55	0.00	1.52	0.00	62.99	323.60	169.67	267.20	55.12	0.00
Number of Rainfall Days	18	14	4	0	1	0	14	17	19	18	4	0.00
Maximum Temp. (^{0}C)	29.2	29.8	32.1	30.6	31.0	32.0	28.5	27.65	28.27	29.52	30.40	31.61
Minimum Temp.(^{0}C)	19.3	19.8	27.5	18.6	20	22	21.2	21.87	21.37	20.71	21.30	20.03

Source: *University of Nigeria, Nsukka Meteorological Station*

Table 3: Effect of poultry manure rates on fruit yield attributes of *Solanum melongena* in 2004 and 2007

Rates of poultry manure (ton/ha)	Number of fruits/plant		Fruit yield/plant (Kg)		Number of fruits/ha		Fruit (ton/ha) Yield/ha		Average weight (g)	Fruit
	2004	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**
0	24.43	38.75	0.26	0.53	977200	154999.7	10.40	21.03	10.64	13.964
5	40.33	70.74	0.40	1.30	1613200	2829476.7	16.00	52.15	9.92	18.05
10	45.20	75.74	0.50	1.402	180800	3025400	19.84	56.08	10.97	18.04
15	64.65	75.64	0.64	1.46	2586000	304273.3	25.25	58.24	9.88	17.93
F-LSD(0.05)	3.16	5.62	0.03	0125	126400	270262.3	0.58	5.07	0.01	1.48

NS = Non-significant at 0.05 level of probability

Table 4: Effect of NPK 15:15:15 fertilizer rates on fruit yield attributes of *Solanum melongena* in 2004 and 2007

Rates of NPK Fertilizer kg/ha	Number of fruits/plant		Fruit yield/plant (Kg)		Number of fruits/ha		Fruit (ton/ha) Yield		Average weight (g)	Fruit
	2004	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**	**2004**	**2007**
0	35.95	40.39	0.37	0.57	143800	1615406.7	14.84	22.71	10.32	14.26
200	43.33	72.71	0.46	1.30	1733200	2908443.3	18.36	52.07	10.59	17.70
350	47.23	75.99	0.48	1.43	1889200	3039800.0	19.20	57.17	10.16	18.14
400	48.13	75.85	0.49	1.39	1925200	3033956.7	19.40	55.55	10.18	17.88
F-LSD(0.05)	3.16	5.62	0.03	0.125	126400	270262.3	0.58	5.07	0.01	1.48

Table 5: Effect of poultry manure (pm) by NPK 15:15:15 fertilizer (NPK) interaction on fruit yield attributes of *Solanum melongena* in 2004 and 2007

PM x NPK interaction	Number of fruits/plant		Fruit yield/plant (Kg)		Number of fruits/ha		Fruit (ton/ha)	Yield	Average weight (g)	Fruit
	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
MoFo	16.05	21.94	0.15	0.32	64200	877640	5.98	12.69	9.33	14.66
MoF1	23.75	40.67	0.27	0.57	950000	1626840	10.93	22.80	11.40	14.32
MoF2	27.50	43.77	0.30	0.554	1100000	1750840	12.01	22.17	10.92	12.97
M1F3	30.43	48.62	0.32	0.66	1217200	1944666.7	17.77	26.44	10.49	12.90
M1F3	34.38	32.17	0.33	0.46	1375200	1286840	13.13	18.25	9.55	14.38
M1Fo	41.05	80.38	0.41	1.47	1642000	3215200	16.52	58.67	10.06	18.98
M1F1	43.88	84.52	0.42	1.66	1755200	3380666.7	16.97	66.47	9.67	19.75
M1F2	42.08	85.88	0.44	1.63	1683200	3435200	17.42	65.20	10.35	19.08
M2Fo	39.73	44.72	0.46	0.63	1589200	1788706.7	18.45	25.35	11.61	14.25
M2F1	45.98	82.00	0.48	1.57	1836200	3280133.3	19.27	62.72	10.48	19.23
M2F2	45.90	88.54	0.51	1.67	1839200	3541600	20.46	66.76	11.14	18.82
M2F3	49.18	87.28	0.53	1.74	1967200	3491160	21.12	69.49	10.73	19.86
M3Fo	53.63	62.71	0.54	0.86	2145200	2508440	21.72	34.54	10.12	13.75
M3F1	62.50	87.79	0.67	1.602	2500000	3511600	26.85	64.08	10.74	18.24
M3F2	71.68	87.15	0.68	1.83	2867200	2886133	27.37	73.27	9.55	21.02
M3F3	70.83	81.62	0.66	1.53	2833200	3264800	26.26	61.06	9.27	18.69
F- LSD(0.05)	6.33	11.245	0.52	0.25	253200	540524.7	1.13	10.14	0.51	2.95

Mo = ton/ha manure; Fo = 0kg/ha fertilizer; M1 = 5 tons/ha manure; F1= 200kg/ha fertilizer; M2 = 10ton/hamanure; F2 = 350kg/ha fertilizer ; M3 = 15ton/ha manure F3 = 400kg/ha fertilizer

The significant effects of both poultry manure applicant and NPK 15:15:15 fertilizer application may be attributed to the low soil fertility of the experimental site. This was evidenced in the result of the soil analysis. Tisdale and Nelson (1975) noted that crop response to fertilizer application is affected by nutrient reserve in the soil. According to them, crop responds more to fertilizer application in soil with very low nutrient content than soil with high nutrient reserve.

Organic fertilizers apart from releasing nutrient elements to the soil have been shown to improve other soil chemical and physical properties which enhance crop growth and development (Salter and Haworth, 1962, Stevenson and Ardakani, 1972, Mbagwu and Ekwealor, 1990,). This may have been responsible for the better performance recorded in plants that were treated with a combination of poultry manure and fertilizer than crops that received either sole poultry manure or sole fertilizer treatments. This agrees with results obtained in other crops (Naik and Ballal, 1968, Magdoff and Amadon, 1980, Mbagwu and Ekwealor, 1990,). Dei (1975) attributed this to increased efficiency in the utilization of inorganic fertilizers as a result of reduced leaching of nutrient.

In addition, poultry manure has also been reported to increase soil pH (Oikeh, 1989), hence the acidic soil of the experimental site which might have caused the unavailability of nutrient element to the crops was checked by the liming potential of organic manure. It was also noted that though the result indicated non-significant organic manure x fertilizer interaction, the combination of 15ton/ha manure and 350kg/ha fertilizer produced the best fruit yield/ha. This however, did not differ significantly from what were obtained when the same 15ton/ha manure rate was combined with 200kg/ha fertilizer rates.

From the above it can be suggested to farmers to use combination of 15ton/ha manure and 200kg/ha fertilizer in garden egg production, as increasing fertilizer rate may not give significant yield increase. Also considering the economic implication in sourcing inorganic fertilizer and the effect on environment, decreasing rate of application may be a better option. Farmers who may want to use only NPK 15:15:15 fertilizer may be advised to use the 350kg/ha rate as further increase did not give significant increase in yield. On the other hand, if poultry manure only is the choice, the highest rate of 15ton/ha is recommended. It is also suggested that further research be made to test the effect of higher rates of poultry manure on the crop.

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