INFLUENCE OF NITROGEN FERTILIZER ON THE GROWTH AND YIELD OF AFRICAN EGGPLANT (*Solanum macrocarpon* L)

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ABSTRACT

The present investigation is to evaluate the effect of nitrogen fertilization on the growth and harvestable yield of African eggplant (*Solanum macrocarpon*). The experiment was carried out at National Institute of Horticultural Research (NIHORT), Ibadan, Nigeria. The experimental treatment of urea (nitrogen fertilizer) applied to *Solanum macrocarpon* (eggplant) are as follows: 15, 30, 45, 60, 75, 90, 105, 120, 135, 150 kg N/ha and 0 (control) kgN/ha. The experiment was laid out in completely randomized design (CRD) having eleven treatments and replicated six times. The parameters assessed and analyzed are plant height, stem girth, number of leaves, number of fruits harvested per plant, weight of harvested leaves (fresh) and dry weight of leaves. The study indicated that nitrogen fertilization produced significant higher values for growth parameters with the application of 150 kgN/ha had the highest mean number of leaves at 38.17 leaves and was not significantly different from the application range of 75 to 150kgN/ha application. The harvestable (edible and economic) yield was also significantly higher as against where there was no addition of nitrogen fertilizer to the soil. In the leaf weight, the fresh and dry showed significant difference among the treatments. 135kgN/ha and 150kgN/ha produced the highest in dry and fresh respectively while the treatment application 15.00kgN/ha and control had the least mean. The promising yield obtained with the additional application of nitrogen fertilizer is a pointer to its potential use in vegetable production in Nigeria. With the use of soil nitrogen fertilizer adds the benefits of high and fast nutrient release of nitrogen will therefore enhance vegetable growth and also enhance its harvestable yield production.

Keywords: *Solanum macrocarpon*, Nitrogen fertilizer, growth, yield.

INTRODUCTION

Solanum macrocarpon L. (African Eggplant) belong to the *Solanaceae* family which includes potato, tomato and sweet pepper (Dupries and Deleener, 1989). It is widely cultivated for its leaves in the warmer and non-arid parts of Africa (Schippers, 2000). *Solanum macrocarpon* in Nigeria is always intercropped with staple food crops like yam and cassava; however, some farmers plant it as a sole crop when the production is market oriented. The crop is widely cultivated across most of the African continent and more intensively in west and east Africa. It is consumed almost on a daily basis by urban families and also represents the main source of income for producing households in the forest zone of West Africa (Danquah-Jones, 2000). In West Africa, the eggfruits are eaten raw, cooked or fried with spices in stews, or dried and pound as condiments (AVRDC, 2008).

Vegetable production in Africa is as old as peasant farming though its cultivation is still at the household level with very few farmers producing on a commercial level. This could be due to the fact that crops such as cereals, roots, and tubers and body-building crops like legumes are given much attention. Cereals and tubers form the bulk of food consumed in the tropics but they are deficient in minerals and vitamins compared to the body requirement to guarantee good healthy living (Ogunlade *et al.*, 2011).

Plant nutrition or soil fertilization is one of the most important factors that that determines the yield of vegetable crops. It affects the accumulation, mineralization and humification of organic matter added to the soil and determines plant production potential (Nakhro and Dkhar, 2010). Soil fertility is a complex quality of soils that is the closest to plant nutrient management. It is the component of overall soil productivity that deals with its available nutrient status, and its ability to provide nutrients out of its own reserves and through external applications for crop production. It combines several soil properties (biological, chemical and physical) all of which affect directly or indirectly nutrient dynamics and availability. Soil fertility is a manageable soil property and its management is of utmost importance for optimizing crop nutrition on both a short-term and a long-term basis to achieve sustainable crop production (Roy *et al.*, 2006).

Fertilizers are soil amendments applied to promote plants growth. The main nutrients present in fertilizers are nitrogen (N), phosphorus (P) and potassium (K) (macro nutrients), and other nutrients (micro nutrients) are added in smaller amount. The amount of fertilizer introduced into the soil, including mineral fertilizers, affects the amount of mineral nitrogen available to plants and the organic carbon content of the soil (Bijlsma and Lambers, 2000).

Nitrogen is one of the major elements for plants growth and development that has an important role in plant nutrition and therefore is the yield limiting factor for plant growth in many areas especially in low organic soils (Najafva *et al.*, 2008). Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids acting as structural compounds of the chloroplast (Basela and Mahadeen, 2008)

Nitrogen fertilizer is known to have been one of the plant nutrients that influence vegetative growth in most crops and subsequently increased yield. Nitrogen fertilizers promote vegetative growth and mainly responsible for deep green colour in plants, which is essential for photosynthesis (Futuless and Bagale, 2007). Nitrogen is considered as one of the essential macronutrients required by the plants for their growth, development and yield (Singh *et al.*, 2003). Moreover, nitrogen is the main constituent of all amino acids in proteins and lipids acting as structural compounds of the chloroplast (Basela and Mahadeen, 2008). The extent of *Solanum macrocarpon* response to nitrogen fertilizer application in Nigeria has not been properly investigated. This probably explained the reason for the scanty information about the effect of nitrogen fertilization on the crop growth and harvestable yield. The utilization efficiency of nitrogen fertilizer for *Solanum macrocarpon* growth and yield response considering the condition of the soil is very important information. So much information is available when the soil condition is very poor considering the general nature of soil as impoverished due to weathering, leaching and intensive cultivation as reported by Akanbi and Togun (2002) but there is a little information of the effect of nitrogen fertilization when the soil is in good conditions to determine the response of the crop in growth and yield in order to boost the productivity of the crop in such condition. Hence the application of nitrogen fertilizers to soil in good condition in order to increase the plant metabolism in chlorophyll, plant tissue, grain protein and nutrient and water uptake so as to boost its productivity. Therefore, increasing demand of food, the requirement for a more environmentally friendly agriculture and future risk arising for climate change are all associated with the urgent need to know nitrogen use efficiency in plants. Therefore this study is to evaluate the effect of nitrogen fertilization on the growth and harvestable yield of eggplant (*Solanum macrocarpon*).

MATERIALS AND METHOD

Experimental Site

The experiment was carried out at the Research plot of National Institute of Horticultural Research (NIHORT), Ibadan, Nigeria during the rainy season of 2018.

Methodology

The *Solanum macrocarpon* (eggplant) NH94/35 seeds were purchased from the seed section of National Institute of Horticultural Research Ibadan. The urea fertilizer was also purchased from Agricultural input shop at Agbeni, Dugbe market, Ibadan, Nigeria. Germination box was filled with top soil and the seed were planted.

The seedlings were transplanted into polythene nylon of 5kg soil. The seedlings transplanted were selected based on being vigorous and uniform in height. Transplanting was done at six weeks after sowing and urea fertilizer was applied at 1 week before transplanting. Necessary agronomic practices such as watering, weeding and pest control were carried using appropriate tools and measures as required. The soil was analyzed before planting for both physical and chemical properties.

Experimental Treatment and Design

The experimental treatment of nitrogen fertilizer (urea) applied to *Solanum macrocarpon* are as follows: (T_0) control 0 kg N/ha, (T_1) 15kg N/ha, (T_2) 30kg N/ha, (T_3) 45kg N/ha, (T_4 -) 60kg N/ha, (T_5 -)75kg N/ha, (T_6 -)90kg N/ha, (T_7) 105kg N/ha, (T_8) 120kg N/ha, (T_9) 135kg N/ha and (T_{10}) 150kg N/ha. The experiment was laid out in completely randomized design (CRD) having eleven treatments and replicated six times.

Data Collection

The following parameters were collected from two weeks after transplanting and at two weeks interval growth parameters of Plant height, Stem girth, Number of leaves, Leaf width and Leaf length were assessed. Yield parameters assessed are Weight of harvested leaves and fruits (fresh) and dry weight of leaves and fruits.

Data Analysis
Data collected were analyzed using analysis of variance (ANOVA) using DSAASTAT statistical software package (Onofri, 2007). And where ANOVA was significant, the means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability.

RESULTS AND DISCUSSION

Pre-Planting Soil physical and chemical parameters
The soil is slightly alkaline (pH of 7.9) with particle size distribution of 79.0%, 19.0% and 2.00% for Sand, Silt and Clay respectively with a textural class of loamy sand (Table 1). The soil organic carbon, total Nitrogen and available phosphorus are 24.1, 2.2kg and 97.00mg/kg. All other inherent mineral nutrients of calcium, magnesium and potassium are high which were higher than the critical levels as suggested by Ibude *et al.*, (1988) and Law-Ogbomo and Osaigboro (2016) stated as 1.50, 0.28 and 0.16cmol/kg respectively. The condition of soil for cultivation of crops is good based on adequate organic carbon, the base saturation and that of the available phosphorus is adequate.

Table 1. Physical and chemical parameters of pre-planted Soil

Parameters	Values
pH in H_2O	7.9
Organic Carbon (g/kg)	24.1
Total Nitrogen "	2.2
Available Phosphorus (mg/kg)	97
Exchangeable Bases (cmol/kg)	
Calcium "	31.00
Magnesium "	32.59
Potassium "	2.54
Sodium "	1.26
Exchangeable Acidity "	0.07
ECEC "	67.46
Base Saturation (g/kg)	999
Micronutrients (mg/kg)	
Mn "	175
Fe "	210
Zn "	212
Cu "	226
Particle Size Distribution (g/kg)	
Sand "	790
Silt "	190
Clay "	20

Growth parameters
Table 2 showed the effect of nitrogen fertilization on the leaf length of eggplant from 2 to 12 weeks after transplanting (WAT). The result obtained showed that there were significant difference among the treatments at 2, 8, 10 and 12 WAT. The T_{I0} application produced the highest while T_1 produced the least mean at 2 to 12WAT. At 12WAT T_{I0} had the highest mean of 25.37cm and was not significantly different from T_9, T_{10} & T_6 application (20.98, 21.12 and

20.47cm respectively). The least mean was recorded in T_1 (13.05cm) and was not significantly different from T_0, T_2, T_3, T_5 and T_7 application.
Table 3 showed the leaf width of Eggplant as affected by nitrogen fertilization. The result obtained showed that there were significant differences among the treatments at 8, 10 and 12 weeks after transplanting (WAT). The Nitrogen fertilization application of T_3, T_7, T_9, T_5 and T_{I0} produced the highest at 2 to 12 WAT while T_1 and T_0 produced the least. At 12WAT, T_{I0} (12.98cm) had the highest leaf width and was not significantly different from T_9 and T_6 application while T_1 (8.17cm) had the least mean and not significantly different from other treatments except T_6, T_9 and T_{I0}.

Table 4 shows the effect of Nitrogen fertilization on the stem girth of Eggplant from 2 to 12WAT. The result obtained showed that there were significant differences among the treatments at 6 and 8WAT while there were no significant differences among the treatments at 2, 4, 10 and 12WAT. At 12WAT, T_0 had the least stem girth of 2.53mm and was not significantly different from other treatments except T_8, T_9 and T_{I0} while the highest stem girth was recorded in T_{I0} (3.13mm) and was not significantly different from T_0 and T_1 application.

Table 5 shows the number leaves of Eggplant as affected by Nitrogen fertilization application at 2 to 12 weeks after transplanting (WAT). The result obtained showed that there were no significant differences among treatments in all the WAT. At 12WAT, the application of T_{I0} (38.17 leaves) had the highest and was not significantly different from T_3, T_6, T_7, T_8 and T_9 application. The least number of leaves was recorded in T_0 having 21.33 leaves.

Table 2: Leaf length of *Solanum macrocarpon* at 2 to 12 weeks after transplanting (WAT) as affected by nitrogen fertilization

(T_{rt}) kgN/ha	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
0	11.03bcd	11.75ab	13.58bc	14.90de	16.03d	15.72bc
(1) 15	9.18d	10.21b	10.85c	14.20e	15.60d	13.05
(2) 30	11.67abcd	14.66ab	15.37abc	18.15cde	18.63bd	16.80bc
(3) 45	11.31bcd	14.43ab	16.65ab	17.95cde	18.48cd	16.25bc
(4) 60	11.23bcd	10.07b	16.27ab	18.67bcd	16.88cd	18.97b
(5) 75	13.08abc	15.40a	17.37ab	21.03abc	20.93abc	16.55bc
(6) 90	13.83ab	12.95ab	15.58abc	19.78abc	20.93abc	20.47ab
(7) 105	13.68ab	13.78ab	16.47ab	16.82cde	16.03d	17.48bc
(8) 120	10.60cd	10.32b	16.25ab	17.15cde	19.27bcd	21.12ab
(9) 135	12.97abc	15.80a	17.52ab	23.08a	23.20ab	20.98ab
(10) 150	14.60a	15.98a	19.40a	22.95ab	25.57a	25.37a

*Means with the same letter are not significantly different at 5% level of probability.

Table 3: Leaf width of *Solanum macrocarpon* at 2 to 4 weeks after transplanting (WAT) as affected by nitrogen fertilization

(T_{rt}) kgN/ha	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
0	7.40cd	7.08 abc	8.55b	8.40d	9.00cde	9.08bcd
(1) 15	7.2cd	6.15c	8.53b	8.63cd	8.47e	8.17a
(2) 30	7.82bcd	8.56abc	10.41ab	10.33bcd	9.23cde	8.77cd
(3) 45	8.33abcd	9.48a	11.03ab	11.03ab	11.25bcd	9.72bcd
(4) 60	8.15abcd	7.33abc	9.80ab	9.90bcd	8.67de	8.98bcd
(5) 75	8.92abcd	9.08ab	11.73ab	11.15ab	14.13a	10.32bcd
(6) 90	9.67ab	7.50abc	9.73ab	11.65ab	11.33bc	11.63ab
(7) 105	9.35abc	8.57abc	12.92a	10.53abcd	9.55cde	8.80cd
(8) 120	7.52cd	6.83bc	11.92ab	10.75abc	11.55abc	9.70bcd

(9) 135	9.12abcd	8.21abc	11.68ab	12.62a	11.15bcd	11.30abc
(10) 150	10.03a	8.75ab	11.23ab	11.73ab	13.55ab	12.98a

*Means with the same letter are not significantly different at 5% level of probability.

Table 4: Stem girth of *Solanum macrocarpon* at 2 to 12 weeks after transplanting (WAT) as affected by nitrogen fertilization.

(T_{rt}) kgN/ha	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
0	1.55a	1.47b	1.75e	1.97c	2.30b	2.53c
(1) 15	1.45ab	1.58ab	1.92cde	2.07bc	2.30b	2.30bc
(2) 30	1.53ab	1.62ab	1.82de	2.08abc	2.70a	2.93abc
(3) 45	1.48ab	1.73a	2.32a	2.50a	2.60ab	2.90abc
(4) 60	1.45ab	1.70a	2.05abcde	2.27abc	2.63ab	2.92abc
(5) 75	1.30b	1.65ab	1.95bcde	2.22abc	2.55ab	2.80abc
(6) 90	1.53ab	1.73a	2.13abcd	2.37ab	2.62ab	2.87abc
(7) 105	1.50ab	1.65ab	2.02abcde	2.20abc	2.55ab	2.80abc
(8) 120	1.30b	1.67ab	1.90de	2.20abc	2.45ab	2.70ab
(9) 135	1.53ab	1.78a	2.23abc	2.43a	2.72a	2.00ab
(10) 150	1.33ab	1.75a	2.27ab	2.43a	2.73a	3.13a

*Means with the same letter are not significantly different from each other at 5% level of probability

Table 5: Number of leaves of *Solanum macrocarpon at* 2 to 12 weeks after transplanting (WAT) as affected by nitrogen fertilization.

(T_{rt}) kgN/ha	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
0	4.83	6.83b	10.33b	14.50b	15.83b	21.33b
(1) 15	5.00	7.83ab	13.83ab	15.67b	17.33b	21.50b
(2) 30	4.83	7.67ab	12.67ab	14.33b	16.33b	23.00b
(3) 45	5.17	9.50a	15.33a	21.67ab	23.33b	29.67ab
(4) 60	4.83	7.50ab	12.50ab	15.50b	20.67b	26.17b
(5) 75	5.17	7.83ab	11.83ab	15.50b	20.33b	25.50b
(6) 90	4.67	8.33ab	13.50ab	17.00b	21.17b	29.33ab
(7) 105	5.00	8.50ab	13.83ab	19.17ab	21.00b	27.00ab
(8) 120	5.50	7.83ab	12.33ab	16.50b	24.50b	30.83ab
(9) 135	4.83	9.50a	14.17ab	17.33b	24.17ab	30.83ab
(10) 150	5.33	9.67a	16.67a	26.33a	33.17a	38.17a

*Means with the same letter are not significantly different from each other at 5% level of probability

Yield Parameters

The harvest fruit weight (fresh and dry) of Eggplant as affected by Nitrogen fertilization as showed in Table 6. The result obtained showed that there were significant differences among the treatments in the fresh fruit weight with the application of T_9 and T_{I0} produced best at 50.13 and 56.98g respectively and they were significantly different from other treatments. The least mean weight was recorded in T_0 and was significantly different from T_1 to T_7 application.

In the dry fruit weight T_{I0} had the highest mean of 3.09g and was not significantly different from other treatment except T_0 and T_1. In the leaf weight, the fresh and dry showed significant difference among the treatments. T_9 and T_{I0} produced the highest in dry and fresh respectively while the treatment application T_1 and T_0 had the least mean.

Table 6: Fresh and dry weight of fruit and leaf harvested of *Solanum macrocarpon* as affected by nitrogen fertilization

	Fruit weight		Leaf weight	
(T_{rt}) kgN/ha	Fresh	Dry	Fresh	Dry
0	14.50c	1.75bc	10.74bcd	0.30d
(1) 15	25.40bc	1.36c	6.44d	0.37cd
(2) 30	25.76bc	2.09abc	9.78bcd	0.40cd
(3) 45	21.74bc	2.35abc	7.47cd	0.30d
(4) 60	22.84bc	2.35abc	7.72cd	0.50cd
(5) 75	18.48bc	2.08abc	11.07bc	1.07abcd
(6) 90	20.52bc	2.34abc	9.76bcd	1.23abc
(7) 105	27.86bc	2.73ab	7.78cd	0.90bcd
(8) 120	32.54b	2.35abc	12.74ab	0.87bcd
(9) 135	50.13a	2.74ab	12.44ab	1.90a
(10) 150	56.98a	3.09a	16.74a	1.50ab

*Means with the same letter are not significantly different from each other at 5% level of probability.

DISCUSSION

The results from this study showed that nitrogen had significant role to play in *Solanum macrocarpon* production. The results from the experiment is in agreement with Amiri *et al.* (2012) who observed that the eggplant crop responds up to the dose of 120 kg of N/ha, while Trani (2014) recommends up to 200 kg of N/ha for cultivation in protected environments. Pervez *et al.* (2004) noted that soil nutrients are very important for the plants height. Wange and Kale (2004) and Aminifard *et al.* (2010) also reported significant improvement in plant height of eggplant due to the application of nitrogen fertilizer. The results obtained in the number of leaves are in conformity with the findings of Wange and Kale (2004) and Oloniruha (2009).

The study indicated that nitrogen fertilization produced higher values for harvestable (edible and economic) yield as against where there was no addition of nitrogen fertilizer to the soil and this could be adduced to the fact that the nutrients in the soil were leached out of the soil because of the intensity of rainfall during the period of study. The application of nitrogen fertilizers to soils is one of the most important means by which crop yields can be increased (Noggle and Fritz, 1976). Murage (1990) reported that in *Solanum nigrum*, increasing nitrogen application rates resulted in more leaves per plant, hence higher yields. This is in contrast with the additional nitrogen sources which made the nutrient available and which were not leached as the control treatment. The positive effect of nitrogen on yield might be due to the stimulating effect of nitrogen on the vegetative growth characters which form the base for flowering and fruiting (Aminifard *et al.*, 2010). Similar results have been reported in experiments on eggplant conducted by Pal *et al.* (2002) and Devi *et al.* (2002).

CONCLUSION

Among the mineral nutrients, Nitrogen is perhaps the most important because of its biological roles and because it is required in large quantities by the plants. In Nigeria and other West Africa countries where *Solanum macrocarpon* is grown as vegetable, most farmers do not apply fertilizer to boost the productivity of the crop. Under continuous cropping, the maintenance of nitrogen content of soil through the use of nitrogen fertilizer is of primary importance to any soil management programme.

Solanum macrocarpon being a widely grown and consumed leafy vegetable crop in Nigeria, with nutrient requirement for its effective growth and productivity, requires that a sustainable and easily available source of nitrogen be sought to ease the twin problem of scarcity and cost associated with mineral fertilizer. This study highlighted the possibility of the use of nitrogen fertilization in the production of leafy vegetables. The promising yield obtained with the additional application of nitrogen fertilizer is a pointer to its potential use in vegetable production in Nigeria. With the use of soil nitrogen fertilizer adds the benefits of high and fast nutrient release of nitrogen which will therefore enhance vegetable growth and also enhance its harvestable yield production.

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