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Influence of Nitrogen Fertilizer Rates on Phenology and Yield of African Eggplant (*Solanum macrocarpon* L.) Cultivars in Minna and Abuja, Nigeria

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Abstract:- Due to the dearth of information on the phenology and yield performance of African eggplant as influenced by nitrogen fertilizer, a research was conducted to determine the variation effects of nitrogen rates at 0, 20, 40, 60, 80 and 100 kg ha-1 on vegetative growth of two African eggplant (*Solanum macrocarpon*) were conducted during the 2013 cropping season at the Federal University of Technology, Minna (90 31'N, 60 27'E; 232 m above sea level) and the National Agricultural Seeds Council (NASC), Technical headquarters, Sheda, Abuja (8°53' N, 7°03' E; 213 m above sea level), both in the Southern Guinea Savanna region of Nigeria. Seeds of the two cultivars (FUTMSm1 and FUTMSm2) were sown on nursery beds for five weeks before transplanting. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications, using a 2 × 6 factorial arrangement. Phenological characters and fruit yield with its components parameters were studied. Correlation analysis was done to check the degree of association between fruit yield and its components. Some of the phenological characters were significantly affected by cultivar and the application of 20 to 40 kg N ha^{-1} at Minna and Abuja locations. Nitrogen rates of 60 kg ha^{-1} significantly gave the highest fruit yield/ha (tons) compared to the Due to the dearth of information on the phenology and yield performance of African eggplant as influenced by nitrogen fertilizer, a research was conducted to determine the variation effects of nitrogen rates at 0, 20, 40, 60, 80 and 100 kg ha-1 on vegetative growth of two African eggplant (*Solanum macrocarpon*) were conducted during the 2013 cropping season at the Federal University of Technology, Minna (90 31'N, 60 27'E; 232 m above sea level) and the National Agricultural Seeds Council (NASC), Technical headquarters, Sheda, Abuja (8°53' N, 7°03' E; 213 m above sea level), both in the Southern Guinea Savanna region of Nigeria. Seeds of the two cultivars (FUTMSm1 and FUTMSm2) were sown on nursery beds for five weeks before transplanting. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications, using a 2 × 6 factorial arrangement. Phenological characters and fruit yield with its components parameters were studied. Correlation analysis was done to check the degree of association between fruit yield and its components. Some of the phenological characters were significantly affected by cultivar and the application of 20 to 40 kg N ha^{-1} at Minna and Abuja locations. Nitrogen rates of 60 kg ha^{-1} significantly gave the highest fruit yield/ha (tons) compared to the control at both locations. There was a significant (<0.01; <0.05) positive correlation between the fruit yield and all other yield components studied except the seedling mortality rate which had a significant (<0.01) negative correlation with the fruit yield. It was concluded that N rates of 20 to 40 kg Nha^{-1} and 60 to 80 kg Nha^{-1}

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significantly affect phenological characters and fruit yield with its components in the two cultivars (FUTMSm1 and FUTMSm2) of African eggplant respectively; and there was a significant (<0.01; <0.05) positive correlation between the fruit yield and most of the yield components studied. As a result of our findings in this study, it is therefore recommended that N rates of 20 to 80 kg Nha^{-1} will be adequate to produce significant phenological characters and fruit yield. A good number of the yield components from this study can be prioritized into breeding programme for improved crop yield of African eggplant by the breeders.

Keywords:- *Nitogen, African Eggplant, Growth, NASC, FUTMINNA.*

I. INTRODUCTION

Solanum macrocarpon L. belongs to the Family Solanaceae alongside with other cultivated species like potato, tomato and pepper (Dupries and Deleener, 1989). The genus Solanum comprises over 1000 species worldwide. Solanum macrocarpon has an African ancestry. It is represented by at least 100 indigenous species in Africa and the adjacent Islands where about 20 species of these are recent introductions.

African eggplant (Solanum macrocarpon) vegetable is a very important source of minerals and protein. Different selections of this crop are being cultivated by farmers and application of fertilizer has been established to be important in its cultivation (Olaniyan and Nwachukwu, 2003) but the extent of Solanum macrocarpon response to Nitrogen fertilizer application in Nigeria has not been well studied which however gives the reason for limited information on the agronomic recommendation for the crop. Furthermore, studies have shown that N application rate varied across locations. Therefore there is a need to determine the optimum rate of N for African eggplant in the Southern guinea savannah region of the country. Generally, there is a dearth of information on phenology characters of African eggplant as influenced by nitrogen fertilizer. Hence the need for this study. Therefore, the general objective of this study is to ascertain the optimum nitrogen fertilizer level that would be required for the phenology characters of African egg-plant (Solanum macrocarpon) in Minna and Abuja, Nigeria.

The specific objectives are to determine:

i. the effect of nitrogen fertilizer on crop phenological characters.
ii. the effect of nitrogen fertilizer on the fruit yield of African eggplant.
iii. the variations in the agronomic characters of two cultivars of African eggplant.

II. MATERIALS AND METHOD

Experimental site, source of seeds and layout Field experiments were conducted during the 2013 growing season. The study was located at Federal University of Technology, Minna (9^0 31'N, 006^0 27'E; 232m above the sea level) and the National Agricultural Seeds Council (NASC), Technical headquarters, Sheda, Abuja (8°53' N, 007°03' E; 213m above the sea level) in the Southern Guinea Savanna region of Nigeria. Seeds of FUTMSm1 and FUTMSm2 cultivars of African eggplant (*Solanum macrocarpon)* were obtained from the stock of Crop Production Department of the Federal University of Technology, Minna. Seeds of two cultivars were sown by broadcasting in well prepared nursery beds and were regularly watered. The seedlings from them were nursed for five weeks before transplanting.

The site at each location was cleared of all vegetation and was manually leveled and ridged 75 cm apart. The area was then marked into plots. Plants of the two cultivars (FUTMSm1 and FUTMSm2) were subjected to six nitrogen fertilizer levels: 0 kg N ha^{-1}, 20 kg N ha^{-1}, 40 kg N ha^{-1}, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 100 kg N ha^{-1} (with urea as source). This gave a 2 x 6 factorial arrangement which was fitted into randomized complete block design (RCBD) with three replications. Each plot measuring 4 m x 2.25 m (9 m^2) contained four ridges spaced 0.75 m apart. Seedlings were transplanted 50 cm apart on the ridges at one per stand (eight seedlings per row). This gave a population of 32 plants per plot which translated to 26,666 plants ha^{-1}. The area of a replicate was 135.625 m^2 (17.5 m x 7.75 m) in dimension and adjacent replicates were separated by gaps of 1.0 m. The total experimental area was 441.88 m^2 (25.25 m x 17.5 m). Half dose of nitrogen fertilizer was applied at 2 – split doses: at two and five weeks after transplanting (WAT) by banding method 15 cm away from the plant. P_2O_5 (with Single super phosphate as source) and K_2O (with muriate of potash as source) were also applied to each plot at 20 kg and 40 kg ha^{-1} respectively at 2 WAT as a basal application. Weeding was carried out twice (at 5 and 9 weeks after transplanting) by the use of hoe. Insect pests were controlled by the use of the Best Action insectide (Cypermethrin 30g/L + Dimethoate 250g/L EC) at 1 litre per hectare.

A. Parameters evaluated

B. Phenological characters

Days to first flower bud formation – days to first flower bud formation from seed sowing of the tagged plants was recorded.

Days to first flower bud opening – days to flowering counted from seed sowing in the nursery to time of first flower opening of the tagged plants was recorded.

Days to 50% flowering – days to 50% flowering counted from seed sowing date at the nursery was recorded.

Days to first fruit formation – number of days from seed sowing to first fruit formation of the tagged plants was recorded.

C. Fruit and Yield Components

Mortality (%) – The number of plants that died between transplanting and first harvesting was counted and expressed in percentage.

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Number of flowers per plant – Mean number of flowers formed per plant by the randomly tagged plants from the beginning of first flower formed until the end of the experiment.

Number of productive branches per plant – Number of fruiting branches produced by the tagged plants was counted and recorded.

D. Earliness of the Fruit

Plant with early fruit (%) – Earliness was determined as the percentage of plants in which commercially mature fruits (evaluated by the colour) were harvested.

Early fruits (no./plant) – Number of commercially mature fruits harvested at 13 WAT (evaluated by the colour) per plant was recorded.

Early fruit yield/plant (g) – The number of early fruits harvested per plant at 13 WAT was weighed using a sensitive scale.

Number of fruit per plant– Total fruit harvested per plant was counted from the first harvest to the last harvest

Fruit Yield per plant (g) – This is the weight of the total fruits harvested per plant.

Fruit Yield per hectare (tons) – Total fruit yield per plot (kg) was extrapolated to obtain yield per hectare.

E. Data collection and analysis

All data from the phenology and fruit yield components were subjected to analysis of variance (ANOVA) using SAS statistical software package (SAS Institute, 2012. Cary, NC). Main and interaction effects were compared using the Least Significant Difference (LSD) at 5 % level of probability and Duncan Multiple Range Test (DMRT) tests at 0.05 level of probability. Data in percentages were transformed to arcsin values before statistical analysis.

III. RESULTS AND DISCUSSION

The results of physicochemical analysis of the pre-planting and post-harvest soils used as shown in Table 1 indicate that the soil was Sandy-Loam and Sandy Clay-Loam in Abuja and Minna respectively. Total Nitrogen, phosphorus, potassium and organic carbon of the soil were low using the standard developed by Esu (1991).

The total amount of rainfall during the growing period of the crop at Abuja and Minna were 895.1 mm and 854.6 mm respectively and the monthly distributions are presented in Table 2.

Table 1: Physicochemical characteristics of soils of experimental sites at a depth of 0 – 15 cm at pre- and post-planting stages at Abuja and Minna in 2013 raining seasonThe higher mortality rate of seedlings to which N was applied especially at the Abuja location agrees with the result obtained for *Solanum retroflexus* by Juma (2006).

The significant increase in the number of productive branches and the number of flowers formed/plant due to application of nitrogen fertilizer in this study agrees with the findings of Aminifard et al., (2010) who evaluated the effect of different N rates on growth and yield of eggplant and recorded the greatest flower number at N application of 100 kg ha-1 and number of lateral branches at 50 kg ha-1 while the least numbers were recorded in the control. Omotoso and Shittu (2007) also reported that okra plants that were fertilized produced more fruiting branches with 300 kg ha-1 of NPK 15:15:15 than those that received lower rates of application (0 and 150 kg NPK ha-1) due to higher nitrogen content which induced higher number of fruiting branches.

- *Plant phenological characters in Abuja*

Table 3 shows the effect of nitrogen rates on phenology characters in the two African eggplant cultivars studied in 2013 in Abuja. The differences between the two cultivars with respect to days to first flower bud opening, days to 50 % flowering and days to first fruit formation were not significant. These traits were however significantly affected by N application. Number of days to first flower bud opening and 50 % flowering were significantly shorter (about 64, 74 and 71 days respectively) in plants from plots to which 20 kg N ha-1 was applied than in those that received 100 kg Nha-1 with values of about 68, 80 and 78 days respectively. The differences among 20 kg N ha-1 and all other N levels were however generally insignificant. Cultivar by nitrogen interaction effects was also non-significant.

- *Plant phenological characters in Minna*

Table 4 shows the effect of cultivar and nitrogen rates on phenological character in African eggplant (Solanum macrocarpon) in 2013 in Minna. The differences between the two cultivars with respect to days to first flower bud opening, days to 50 % flowering and days to first fruit formation were statistically insignificant. Number of days to first flower bud opening, 50 % flowering and first fruit formation were significantly shorter in plants to which 20 – 40 kg N ha-1 were applied than in those to which 0 (control) and 60 – 100 kg N ha-1 were applied.

Mean values on fruit yield and yield components as affected by cultivar type and nitrogen application are presented in Table 5. There was no significant cultivar effect on the percentage mortality rate, number of flower formed per plant, number of productive branches/plant, number of early fruits/plant (at 13 WAT), weight of early fruits/ plant, number of fruit produced/plant and average fruit yield/plant at the Abuja location. However, greater percentage of FUTMSm2 plants produced fruits significantly earlier than FUTMSm1 plants. It is further shown in Table 4.8 that FUTMSm1 cultivar produced higher fruit yield/hectare than the FUTMSm2. Table 6 shows that the superiority of FUTMSm2 over FUTMSm1 plants was recorded only at 60 and 80 kg N ha^{-1}. Varying nitrogen had significant effects in all the parameters studied except the number and weight of early fruits/plant (at 13 WAT). Application of 0 and 20 kg N ha^{-1} resulted in the lowest

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mortality while the highest mortality was recorded when 100 kg N ha^{-1} was applied to plants. However, the differences in the incidences of mortality amongst plants of the plots which received 40, 60, 80 and 100 kg Nha^{-1} were not significant. Number of fruiting branches/plant was not significant among 0 – 80 kg N ha^{-1}. Application of 100 kg N ha^{-1} resulted in a significant reduction in the number of fruiting branches compared to 20 – 80 kg N ha^{-1}. Percentage of plants with early fruit was significantly higher with the application of 0 – 40 kg N ha^{-1} than at 60 – 100 kg N ha^{-1}. The number and weight of early fruits/plant (at 13 WAT) were not significantly influenced by N application. The total number of fruits/plant was significantly higher at 40, 60 and 80 kg N ha^{-1} than when N was not applied (control). The values for 0, 20 and 100 kg N ha^{-1} and those for 20 – 100 kg N ha^{-1} were similar. Average fruit yield/plant was significantly higher at 60 kg N ha^{-1} than at all other N rates except 80 kg N ha^{-1}. The highest fruit yield/hectare was recorded at 60 kg N ha^{-1} but the value was similar to those recorded when N was applied at 20 and 80 kg Nha^{-1}.

- *Fruit yield and yield components in Minna*

Table 7 shows the mean values on fruit yield and yield components of African eggplant as affected by cultivar type and nitrogen rates in Minna. It shows that there was no significant cultivar effect on the percentage mortality rate, number of productive branches/plant, number of early fruits/plant (at 13 WAT), weight of the early fruits/plant, number of fruits produced/plant, average fruit yield/plant and fruit yield/hectare. However, FUTMSm2 cultivar formed significantly many more flowers than the FUTMSm1 and greater percentage of FUTMSm2 plants produced fruits earlier than FUTMSm1 plants. Table 8 shows that the superiority of FUTMSm2 over FUTMSM1 plants in respect of the number of flowers formed per plant was recorded only at 80 kg N ha-1 and 100 kg N ha-1. Application of different nitrogen rates had significant effects on all the parameters studied except the percentage of plants with early fruit (at 13 WAT), number of early fruits/plant (at 13 WAT) and weight of the early fruits/plant. Application of 0 and 60 kg N ha-1 gave the lowest mortality while the highest mortality was recorded at 20 and 100 kg N ha-1. However, the differences among 0, 40 and 100 kg N ha-1 were not significant. The number of flowers formed was significantly highest in plants to which 100 kg N ha-1 was applied but the value recorded was not significantly different from those at 80 and 60 kg N ha-1. Non application of N (control) resulted in a significant reduction in the number of fruiting branches. The values recorded for this trait were not significant amongst all the rates of N application ha-1. Although the total numbers of fruits per plant was higher with the application of 80 kg N ha-1 which, the value was statistically similar with the numbers recorded at 20, 40, 60 and 100 kg N ha-1. Zero N application ha-1 produced the lowest number of fruits but the value obtained was similar to those at 20 and 40 kg N ha-1. Average fruit yield/plant was highest at 60 kg N ha-1 but statistically similar to other N rates. Yield was poorest at 0 kg N ha-1 (control) but value was statistically similar to those at 20 and 40 kg N ha-1. Fruit yield/hectare was best at 60 kg N ha-1 but similar to values recorded when N was applied at 40, 80 and 100kg N ha-1. Yield was poorest in the control.

Correlation analysis of the fruit yield and yield components

The mortality rate (M %) of the plant had a significant positive correlation with the number of flowers formed per plant, total fruit plant and average fruit yield per plant but had a significant negative correlation with the fruit yield/ha. There was no significant correlation between the mortality rate of the plant with other parameters studied such as the number of productive branches, percentage of early fruit formed which are negatively non-significant correlated, number of early fruit formed and the weight of the early fruit formed. Number of flowers formed per plant (NOFF) had a significant (<0.01) positive correlation with all other yield components and fruit yield. Number of productive branches (NOPB) had a significant positive correlation with the total fruit formed/plant, average fruit yield and fruit yield/ha. There was no significant correlation between the numbers of productive branches with the percentage of early fruit formed, number of early fruits and weight of early fruits formed. Percentage of early fruit formed (PEF) had a significant (<0.01; <0.05) positive correlation with the number of early fruits formed, weight of the early fruits and the fruit yield but had non-significant correlation with total fruit/plant and average fruit yield/plant. Number of early fruit formed (EF) had a significant (<0.01) positive correlation with the weight of the early fruit formed, total fruit/plant, average fruit yield and fruit yield. Weight of the early fruits (WEF) also had a significant (<0.01) positive correlation with the total fruit formed/plant, average fruit yield and fruit yield. Total fruit (TF) produced had a significant (<0.01) positive correlation with the average fruit yield and fruit yield. Average fruit yield (AFY) had a significant (<0.01) positive correlation with the fruit yield (Table 9).

IV. DISCUSSION

The delay in attaining first flower bud opening, days to 50 % flowering and days to first fruit formation when 100 kg N ha-1 was applied agrees with the findings of Law-Ogbomo and Egharevba (2009) which showed that as the NPK fertilizer rates was increased from 0 kg NPK/ha to 400 kg NPK/ha on two tomato cultivars, days to reaching 50% flowering were increased; the earliest bud break were recorded at 75 kg NPK/ha. Increase in N application up to 160 kg ha-1 has also been reported to cause delay in the maturity of Canola up to 176 days (Gulzar et al., 2006). Akanbi et al., (2010) also reported that such delay is known to cause an extension of crop vegetative growth at the expense of reproductive phase under luxury consumption of the available soil nutrients. The higher mortality rate of seedlings to which N was applied especially at the Abuja location agrees with the result obtained for Solanum retroflexus by Juma (2006). The significant increase in the number of productive branches and the number of flowers formed/plant due to application of nitrogen fertilizer in this study agrees with the findings of Aminifard et al., (2010) who evaluated the effect of different N rates on growth and yield of eggplant and recorded the greatest flower number at N application of 100 kg ha-1 and number of lateral branches at 50 kg ha-1 while the least numbers were recorded in the control. Omotoso and Shittu (2007) also reported that okra plants that were fertilized produced more fruiting branches with 300 kg ha-1 of NPK 15:15:15 than those that received lower rates of

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application (0 and 150 kg NPK ha-1) due to higher nitrogen content which induced higher number of fruiting branches.

The significantly higher total number of fruit formed/plant which was recorded with the N rates of 40 to 80 kg/ha in Abuja and 60 to 100 kg/ha in Minna agrees with the findings of Akanbi et al., (2007) and Aujla et al., (2007) who reported that increments in the nitrogen rate of the fertilizers increased the number of fruits. Ekwu et al., (2012) also reported that the highest number of fruits were obtained at 150 kg NPK (15:15:15) /ha while the least was at 0 kg NPK/ha. Olaniyan et al., (2005) also reported that African eggplant grown in non-fertile soil without fertilizer supplementation produced fruits which were smaller and fewer in numbers. Rosati et al., (2002) reported that increments in the nitrogen rate of the fertilizers increased the number of eggplant fruits. The superiority of FUTMSm2 cultivar over FUTMSm1 cultivar in respect of earliness of fruiting at 60 and 80 kg/ha N rates and also the significantly greater number of flowers/plant obtained in the former over the latter at 80 and 100 kg/ha N rates might be due to the attribute of the former's genetic superiority in utilizing the fertilizer towards its physiological development. Boroujerdnia and Ansari (2007) also recorded significant interaction between nitrogen fertilizer and cultivar on some lettuce growth parameters. Differences between cultivars were tied to adaptability. The enhance fruit yield with increase in N rate in this study is in agreement with the findings of Olaniyan et al., (2005) which showed that fertilizer application generally increased fruit production in African eggplant (S. macrocarpon). Aminifard et al., (2010) similarly reported that increasing the N levels of the fertilizers to 50 kg N/ha significantly increased the yield of eggplant while a decrease was recommended at the highest rate of nitrogen (150 kg N/ha). This result is also consistent with those reported by Devi et al., (2002) and Aujla et al. (2007) which showed that increasing the rate of nitrogen fertilizers increased the yield of the eggplant fruit.

The combined Pearson's correlation matrix among yield characters of Solanum macrocarpon for both varieties and locations showed a significant association ($p<0.05$) for most traits considered in this study. Proper knowledge of genotypic correlation among traits is essential for selection, thus, tandem selection may be effective when positive correlations exist between the trait selected for and other characters of interest (Yunusa and Adeoti, 2014). The reason behind significant ($P<0.05$) positive correlation recorded for mortality and number of flowers formed was because only living plant can bear flower. Highest significant correlation was obtained for the association of TF/Plant and AFY (g). This must have resulted due to the fact that both TF/Plant and AFY (g) are similar traits. This result is at variance with that of Tatis et al., (2009) which showed a significant and negative correlation between fruit number/plant and fruit weight/plant of Solanum melongena. The significant positive correlation between fruit yield/ha and all the other traits except the mortality rate (which showed significant negative correlation) suggests that selection for these traits would lead to higher yield. Similar results showing significant correlation among yield characters of Solanum gilo Raddi in Ghana was reported by Danquah and Ofori (2004).

Table 1: Physicochemical characteristics of soils of experimental sites at a depth of 0 – 15 cm at pre- and post-planting stages at Abuja and Minna in 2013 raining season

Soil Properties	Pre - planting soil test analysis		Post -planting soil test analysis	
	Abuja	Minna	Abuja	Minna
Particle size distribution (gkg^{-1})				
Sand	820	700	760	740
Silt	150	70	80	120
Clay	30	230	160	140
Soil textural class	SL	SCL	SL	SCL
Soil pH (H_2O 1:1)	6.8	7	6.3	6
Soil pH (0.01 M $CaCl_2$)	5	5.2	5.4	5.3
Organic Carbon (g/kg)	30	38	48	40
Avail. P (mg/kg)	5.29	5.8	8.5	7.2
Total Nitrogen (g/kg)	0.36	0.33	0.46	0.43
Exchangeable bases ($Cmolkg^{-1}$)				
Ca^{2+}	1.56	1.45	1.76	2.01
Mg^{2+}	0.88	0.74	1.44	1.84
K^{+}	0.17	0.23	0.26	0.38
Na^{+}	0.09	0.16	0.17	0.21
Exchangeable acidity (**$Cmol\ kg^{-1}$**) $Al^{3+} + H^{+}$	0.07	0.06	0.02	0.03

SL = Sandy loam
SCL=Sandy clay loam
Avail. P= Available phosphorous

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Table 2: Abuja and Minna monthly rainfall data (mm) during the field experimentation period (May – December, 2013)

Month	Location	
	Abuja	**Minna**
May	124.1	46.6
June	162.7	215.8
July	192.8	140.1
August	140.2	222.4
September	132.0	207.2
October	143.3	69.1
November	0	0
December	0	0
TOTAL	**895.1**	**901.2**

Source: Nigerian Meteorological Agency, Abuja and Minna, Airports (2014)

Table 3: Effect of cultivar and nitrogen rates on the phenology of African eggplant (*Solanum macrocarpon*) in 2013 at Abuja at 4 – 14 WAT

Treatment	**Phenology characters**			
	DTFFBO	**DT50F**	**DTFFF**	
Cultivar (C)				
FUTMSm1	65.22	75.63	83.40	
FUTMSm2	65.45	74.31	82.52	
Lsd (0.05) sig. level	NS	NS	NS	
Nitrogen rates (N) (Kgha^{-1})				
0	65.23ab	74.11ab	81.17a	
20	63.53b	71.28b	79.93a	
40	62.98b	74.53ab	81.55a	
60	66.37ab	76.95ab	85.54a	
80	65.97ab	75.28ab	84.23a	
100	67.95a	77.67a	85.33a	
SE±	1.26	2.14	2.03	
Interaction				
C x N	NS	NS	NS	

N means with the same letter(s) within the same column are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).
NS = Not significant.
DTFFBO = Days to first flower bud formation.
DT50F = Days to 50% flowering.
DTFFF = Days to first fruit formation.

Table 4: Effect of cultivar and nitrogen rates on some phenology traits of African eggplant (*Solanum macrocarpon*) in 2013 at Minna at 4 – 14 WAT

Treatment	Phenology traits			
	DTFFBO	DT50F	DTFFF	
Cultivar (C)				
FUTMSm1	66.16	75.09	80.69	
FUTMSm2	66.59	74.86	80.96	
Lsd (0.05) sig. level	NS	NS	NS	
Nitrogen rates (N) (Kgha^{-1})				
0	67.50b	76.56b	81.80b	
20	63.57c	71.22d	76.70c	
40	64.37c	72.50d	78.17c	
60	66.60b	74.94c	81.43b	

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80	66.37b	76.24bc	82.27b	
100	69.83a	78.39a	84.57a	
SE±	0.65	0.55	0.57	
Interaction				
C x N	NS	NS	NS	

N means with the same letter(s) within the same column are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).
NS = Not significant.
DTFFBO = Days to first flower bud opening.
DT50F = Days to 50% flowering.
DTFFF = Days to first fruit formation.

Table 5: Effect of cultivar and nitrogen rates on fruit yield and yield components in 2013 at Abuja experimental site.

	Fruit yield and yield components								
Treatment	**M (%)**	**NOFF**	**NOPB**	**PEF (%)**	**EF**	**WEF(g)**	**NOF/Plt**	**AFY (g)**	**FY/ha(tons)**
Cultivar (C)									
FUTMSm1	22.57	21.56	4.89	57.78	2.61	178.41	14.72	924.18	12.85
FUTMSm2	30.96	23.88	4.89	76.67	2.78	188.94	15.98	927.16	9.75
Lsd (0.05) sig. level	NS	NS	NS	*	NS	NS	NS	NS	*
Nitrogen rates (N) ($Kgha^{-1}$)									
0	0.17c	19.47b	4.57ab	80.00ab	2.31a	152.75a	11.16b	661.30c	9.28c
20	6.25c	21.97ab	5.20a	83.33ab	2.98a	194.82a	14.91ab	839.60bc	13.96ab
40	33.33ab	24.40a	5.22a	86.67a	3.23a	206.36a	16.77a	937.40b	10.59c
60	27.08bc	25.26a	5.05a	53.33c	2.83a	199.51a	18.57a	1196.20a	15.28a
80	36.46ab	23.17ab	5.10a	60.00bc	2.48a	179.08a	15.53a	1069.7ab	11.66a-c
100	57.29a	22.05ab	4.20b	40.00c	2.31a	169.55a	15.18ab	849.90bc	7.04c
SE±	9.22	1.49	0.28	8.40	0.35	27.08	1.43	84.61	1.58
Interaction									
C x N	NS	NS	NS	*	NS	NS	NS	NS	NS

N means with the same letter(s) within the same column are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).
NS = Not significant.
* = Significant a P<0.05 level of probability.

M (%) = Mortality (plant dead at the end of the experiment). WEF (g) = Weight of the early fruit/plant
NOFF = Number of flowers formed/plant NOF = Number of fruits/plant.
NOPB = Number of productive branches/plant AFY (g) = Average fruit yield/plant.
PEF (%) = Percentage of plants with early fruit. FY (tons) = Fruit yield /hectare.
EF (no/plant) = Number of early fruit at 13 WAT.

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Table 6: Cultivar by nitrogen rate interaction effects on the percentage of plants with early fruit in 2013 at the Abuja experimental site

Cultivars	Nitrogen rates (kg/ha)					
	0	20	40	60	80	100
FUTMSm1	80.00a	80.00a	86.67a	20.00b	40.00b	40.00b
FUTMSm2	80.00a	86.67a	86.67a	86.67a	80.00a	40.00b
SE±	11.88					

Means with the same letter(s) are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).

Table 7:Effect of cultivar and nitrogen rates on fruit yield and yield components in 2013 at Minna experimental site

Treatment	Fruit yield and yield components								
	M (%)	NOFF	NOPB	PEF (%)	EF	WEF(g)	NOF/Plt	AFY (g)	FY/ha(tons)
Cultivar (C)									
FUTMSm1	12.85	14.85	4.75	28.89	1.38	86.32	11.4	547.88	8.59
FUTMSm2	8.68	17.6	5.07	60	2.05	114.91	13.4	564.48	9.23
Lsd (0.05) sig. level	NS	*	NS	*	NS	NS	NS	NS	NS
Nitrogen rates (N) ($Kgha^{-1}$)									
0	3.13b	10.97c	3.50b	43.33a	1.58a	84.22a	8.18b	351.74b	6.11c
20	18.75a	14.93bc	5.32a	46.67a	1.32a	70.38a	11.80ab	544.54ab	7.98bc
40	12.50ab	15.03bc	4.83a	50.00a	1.82a	122.08a	11.42ab	526.47ab	8.26a-c
60	4.17b	17.40ab	5.20a	40.00a	1.92a	120.92a	14.51a	675.95a	11.57a
80	9.38ab	19.23a	5.50a	53.33a	1.77a	94.37a	15.32a	646.67a	10.42ab
100	16.67a	19.78a	5.10a	33.33a	1.90a	111.73a	13.17a	591.70a	9.12a-c
SE±	3.56	1.4	0.33	8.49	0.4	28.77	1.35	67.51	1.18
Interaction									
C x N	NS	*	NS	NS	NS	NS	NS	NS	NS

N means with the same letter(s) within the same column are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).

NS = Not significant.
* = Significant a P<0.05 level of probability.
M (%) = Mortality (plant dead at the end of the experiment).
WEF (g) = Weight of the early fruit/plant
NOFF = Number of flowers formed/plant
NOF = Number of fruits /plant (no).
NOPB = Number of fruiting branches/plant
AFY (g) = Average fruit yield/plant.
PEF (%) = Percentage of plants with early fruit.
FY (tons) = Fruit yield/hectare.
EF (no/plant) = Number of early fruit at 13 WAT.

Table 8: Cultivar by nitrogen rate interaction effects on number of flower formed per plant of African eggplant in Minna

Cultivar	**Nitrogen rates (kg. N/ha)**					
	0	**20**	**40**	**60**	**80**	**100**
FUTMSm1	12.73cd	15.67bc	15.07bc	15.53bc	14.27b-d	15.83bc
FUTMSm2	9.20d	14.20b-d	15.00bc	19.27ab	24.20a	23.73a
SE±	1.98					

Means with the same letter(s) are not significantly different at P<0.05 according to Duncan Multiple Range Test (DMRT).

Table 9: Correlations analysis for the fruit yield and yield components

	Traits								
Traits	M (%)	NOFF	NOPB	PEF (%)	EF	WEF (g)	TF/Plt	AFY (g)	FY/ha (tons)
M (%)	1	.272(*)	0.001	-0.194	0.052	0.185	.236(*)	.335(**)	-.390(**)
NOFF	_	1	.349(**)	.309(**)	.534(**)	.554(**)	.771(**)	.763(**)	.431(**)
NOFB	_	_	1	0.08	0.126	0.059	.486(**)	.317(**)	.260(*)
PEF (%)	_	_	_	1	.417(**)	.365(**)	0.098	0.153	.258(*)
EF	_	_	_	_	1	.901(**)	.446(**)	.515(**)	.478(**)
WEF (g)	_	_	_	_	_	1	.459(**)	.627(**)	.469(**)
TF/Plt	_	_	_	_	_	_	1	.838(**)	.530(**)
AFY (g)	_	_	_	_	_	_	_	1	.617(**)
FY/ha (tons)	_	_	_	_	_	_	_	_	1

** Correlation is significant at the 0.01 level (2-tailed). M (%) = Mortality (plant dead at the end of the experiment).

* Correlation is significant at the 0.05 level (2-tailed). WEF (g) = Weight of the early fruit/plant.

FY (tons) = Fruit yield /hectare. TF (no/plant) = Total fruits/plant.

NOFF = Number of flowers formed/plant. NOPB = Number of productive branches/plant.

AFY (g) = Average fruit yield/plant. PEF (%) = Percentage of plants with early fruit. EF (no/plant) = Number of early fruit

V. CONCLUSION

It is concluded from this study that N rates of 20 to 40 kg Nha-1 and 60 to 80 kg Nha-1 significantly affect phenological characters and fruit yield with its components in the two cultivars (FUTMSm1 and FUTMSm2) of African eggplant respectively. Although, N rates of 20 to 80 kg Nha-1 could be adequate for the production of FUTMSm1 and FUTMSm2 cultivars. FUTMSm1 cultivar of African eggplant was superior to FUTMSm2 because it was significantly ($P < 0.05$) better in respect percentage of plants with early fruit, weight of the early fruit, number of flowers formed per plant and the fruit yield. Lastly, there was a significant (<0.01; <0.05) positive correlation between the fruit yield and all other yield components studied except for seedling mortality rate with which it had a significant (<0.01) negative correlation.

Therefore, as a result of our findings in this study, it is recommended that N rates of 20 to 80 kg Nha-1 will be adequate to produce significant phenological characters and fruit yield. A good number of the yield components from this study can be prioritized into breeding programme for improved crop yield of African eggplant by the breeders.

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