ISSN: 2456-8643

EFFECT OF NITROGEN RATES ON GROWTH, FRUIT AND SEED YIELD OF OKRA (Abelmoschus esculentus L. Moench)

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https://doi.org/10.35410/IJAEB.2023.5797

ABSTRACT

A Field trial was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna (Southern Guinea Savanna ecological zone of Nigeria) during the 2019 and 2020 cropping seasons. The experiment was laid out in a Randomized Complete Block Design and replicated three times. The treatments consisted of two okra varieties (NHAe47-4 and LD 88) and five rates of nitrogen fertilizer (0, 30, 60, 90 and 120 kg N ha-1). Each plot measures 2×5.25 m (10.5m2) comprising of eight ridges. Parameters measured included days to first flower bud initiation and opening, days to 50% flowering, plant height, number of leaves, abortion incidence, number of productive branches, number of fresh fruits, number of seeds, weight of seed and 100 seed weight were determined among others. Data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test. Application of 90kg N/ha to okra is therefore suggested for good growth, improved fruit and seed yield in the studied zone. NHAe47-4 fruits contained more number of seeds than LD88 variety.

Keywords: Okra, Nitrogen, Growth And Seed Yield.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the most widely known and utilized species of the family Malvaceae (Iyagba *et al.*, 2013) and an economically important vegetable crop grown in tropical and sub-tropical parts of the world. It is also known as ladies' finger reported to have originated from Ethiopia (Sathish and Eswar, 2013) and was then propagated in North Africa, in the Mediterranean, in Arabia and India by the 12th century BC.

The potential of okra as both leafy and fruit vegetable has not been fully tapped. The need to increase and strengthen the production of vegetables as well as seed support system at farms, villages, communities, institutional, national and regional levels have been reported by Yakubu and Abubakar (2017) due to the numerous nutritional and economic benefits of the crop. Okra is a multipurpose crop due to its various uses of the fresh leaves, buds, flowers, pods, stems and seeds (Mihretu *et al*., 2014). It can be cultivated as a garden crop as well as on large commercial farms (Tripathi *et al.*, 2011). In West Africa, Nigeria is the largest producer (1,100,000 t) followed by Cote d'Ivoire, Ghana and others (FAO, 2013).

Fertilizer affects the quality and productivity of soils and crops (Watts *et al.,* 2010). Weak vegetative growth, poor fruit setting, low fruit and seed yield resulting from inadequate levels of the primary soil nutrients (namely Nitrogen (N), Phosphorus (P) and Potassium (K)) have been reported by Liu *et al,* (2010). Nitrogen considerably influences the utilization of P and K and other plant nutrients in all plants (Watts *et al.,* 2010). Nitrogen is the important part of plant parts such as chlorophyll, amino acid, proteins and pigments. It is most essential for vigorous growth branching/tillering, leaf development and enlargement root expansion, high photosynthetic activity and formation of protoplasm (Ogundare *et al.,* 2015).

The proper management of this nutrient contributes to the vegetative growth and increase in the productivity of the cultures; therefore, it performs important structural function and is a part of several organic compounds that are essential for the plant, such as amino acids, proteins, and proline (Medeiros *et al.,* 2017). Nitrogen mobilizes the process of flower opening, fruit setting and fruit development. Seeds continue to develop and mature in the fleshy fruits until they got extracted from fruits (Nitsch, 2012). The objectives of the study were to determine the effect of nitrogen rates on growth, fruits and seed yield of two okra varieties.

2.MATERIALS AND METHODS

Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna (latitude 9º 51 ^{1}N and longitude 6º 44 ^{1}E) during the 2019- 2020 cropping seasons. Soils in Minna originated from basement complex rocks and generally are classified as Alfisols (Lawal *et al*., 2012). Before land preparation, Soil samples were collected from 0-15cm depth with an auger from 10 points along four diagonal transects. The samples were bulked into four composite samples. The samples were then air dried and sieved through 2mm and 0.5mm sieve. The samples were analyzed for particle size distribution, pH 1:2 (H_2O and $CaCl_2$), Organic carbon, total nitrogen, available phosphorus, exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}), exchangeable acidity (Al^{3+} + H^{+}) and effective cation exchange capacity following the procedures described by Agbenin (1995). Seeds of two okra varieties (NHAe 47-4 and LD 88 were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State Nigeria.

The land was manually cleared followed by ploughing with a tractor. Ridges of 2m length at 75 cm apart were made in each plot. The plots size was 2m × 5.25 m (10.5m^{2}) comprising of 8 ridges. The treatments were a factorial combination of two okra varieties (NHAe47-4 and LD 88) and Five N levels, (0, 30, 60, 90 and 120 kg ha^{-1}) laid out in Randomized Complete Block Design (RCBD) with three replications. Three seeds were manually sown per hole at 0.5m apart and later thinned to one seedling per stand at two weeks after planting (2WAP). Phosphorus and potassium fertilizer at 50 kg ha^{-1} each was applied in all the plots at 2WAP as basal application using single super phosphate and muriate of potash respectively. Urea was applied in two split doses (at 2 and 4WAP) to supply Nitrogen at different rates (0 kg N ha^{-1}, 30 kg N ha^{-1}, 60 kg N ha^{-1}, 90 kg N ha^{-1} and 120 kg N ha^{-1}). Weeding was carried out at two weeks intervals manually. Incidence of insect pests was kept down with the application of Zap® a.i (Lambda Cyhalothrin 25g/L), at 0.005kg a.i/ha. The insecticide was applied as from 2WAP till harvesting stage.

The parameters measured/recorded include:

1. Days to first flower bud sight – This was recorded by counting the number of days from sowing to the first flower bud sight.
2. Days to first flower opening – This was recorded by counting the number of days from sowing to the first flower opening,
3. Days to 50% flowering – This was recorded by counting the number of days from sowing to when half of the plant population flowered.
4. Number of leaves was determined by counting the number of leaves at first flower bud sight, first flower opening, 50% flowering and at plant maturity, excluding the coteledonary leaves.
5. Plant height (cm) was measured from the base of the plant to the tip of the last leaf, using a meter rule at first flower bud sight, first flower opening, 50% flowering and at maturity.
6. Flower abortion incidence and numbers of productive branches at maturity was recorded by counting the number of flowers that fall after formation (opening).
7. Number of fresh fruits per plot was determined by counting fruits harvested per plot, each harvest will be done at five days interval.
8. Weight of fresh fruits per plot was determined by weighing fruits at each harvest per plot using mettler weighing balance and the sum of all the weights will be recorded.
9. Number of seeds and weight of seed was also determined.
10. 100–Seed weight determination Four replicates of 100 seed from each seed lot will be counted and weighed on a Mettler balance and the means will be calculated and expressed in grams.

The data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Student- Newman Keuls (SNK) Test.

3.RESULTS

The results of the chemical and physical properties of the soil in the experimental sites before the two cropping years 2019 and 2020 are presented in the Table 1. The particle size distribution showed that the soil of the site is loamy sand in texture with a moderate pH indicating the soil to be slightly acidic (H_2O) 6.7, 6.8 and (CaCl) 5.5, 6.1 respectively. Soil organic carbon (SOC) 4.5, 4.51 and Soil Total N 1.21, 1.23 was found to be low. The available phosphorus 8.25, 8.50 and ECEC 8.2, 7.69 respectively of the soil were also found to be low.

The Exchangeable bases (C mol kg^{-1}) Ca2+ 3.75, 3.85, K+ 0.07, 0.03 and Na+ 0.17, 1.55 respectively were considered to be moderate. The exchangeable Mg2+ 3, 2.90 was considered sufficient to support plant growth (Marschner, 2012).

Days to first flower bud site, opening and 50 % flowering

The effect of nitrogen rates on days to first flower bud site, opening and 50 % flowering of two okra varieties in 2019 and 2020 is presented in Table 2. Days to first flower bud site and opening was significantly different among the varieties in 2019 only but was not significant on days to 50

ISSN: 2456-8643

% flowering. At first flower bud site in 2019, LD 88 had earlier days to first flower bud site (59.0) than NHAe47 – 4 which took longer days to first flower bud site (74). At first flower bud opening in 2019, NHAe47 – 4 recorded the earliest days to first flower bud opening (72.0) than LD 88 which had the longer days to first flower bud opening (74).

Nitrogen rates had a significant effect on days to first flower bud site, opening and 50 % flowering. At first flower bud site in 2019, the application of 120 kg N ha^{-1} had the earliest days to first flower bud site (57.0) than the other nitrogen rates compared with 0 and 30 kg N ha^{-1} which recorded statistically similar longest days to first flower bud site (61.0 and 62.0). At first flower bud opening in 2019, zero application had the earliest days to first flower bud opening (71.0) than the plots with nitrogen application compared with the application of 120 kg N ha^{-1} which took longer days to first flower bud opening (75.0). At 50 % flowering in 2019, the applications of 60 and 90 kg N ha^{-1} produced statistically similar earliest days to 50 % flowering (78.0 and 81.0) than 0, 30 and 120 kg N ha^{-1} which had similar longest days to 50 % flowering (88.0, 86.0 and 87.0). In 2020, the application of 60 kg N ha^{-1} had the earliest days to 50 % flowering than the other rates compared with 0 and 30 kg N ha^{-1} which had similar longest days to 50 % flowering (88.0).

Number of leaves

The effect of nitrogen rates on number of leaves of two okra varieties at different stages of growth in 2019 and 2020 is shown in Table 3. Number of leaves was significantly different among the okra varieties at first flower bud site in 2020, first flower bud opening and at maturity in 2019. The variety LD 88 consistently produced significantly higher number of leaves (10.33, 14.0 and 4.0) than NHAe47 – 4 which consistently produced the lowest number of leaves (9.60, 12.0 and 3.0). Nitrogen rates had a significant effect on number of leaves throughout the growth stages except at 4 WAS in 2020, first flower bud site and at maturity in 2019 which were not significant. At 4 WAS in 2019, the application of 60 kg N ha^{-1} recorded significantly higher number of leaves (7.67) statistically similar with the application of 30 and 90 kg N ha^{-1} (6.83 and 7.50) compared with zero application which recorded the lowest number of leaves (5.50) similar with the application of 120 kg N ha^{-1} (6.00).

At first flower bud site in 2020, the application of 120 kg N ha^{-1} produced significantly higher number of leaves statistically similar with the applications of 60 and 90 kg N ha^{-1} (10.0) compared with the applications of 0 and 30 kg N ha^{-1} which recorded statistically similar lowest number of leaves (9.50 and 9.83). at first flower bud opening, the application of 120 kg N ha^{-1} consistently recorded the highest number of leaves (10.50 and 14.2) in both years respectively than the other rates compared with zero application in 2019 (12.0), zero application, 30 and 60 kg N ha^{-1} which recorded similar lowest number of leaves (13.17, 14.67 and 14.67) in 2020 in this study. At 50 % flowering, all the plots with nitrogen application recorded significantly similar highest number of leaves than zero application which had the lowest in 2019. In 2020, the applications of 90 and 120 kg N ha^{-1} recorded significantly highest number of leaves (17.67) though statistically similar with the other rates of nitrogen applications compared with zero application which recorded the lowest number of leaves (14.0). At maturity in 2020, the

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application of 60 kg N ha^{-1} recorded higher number of leaves (4.83) than the other rates compared with zero application which had the lowest number of leaves (3.33) in this study.

Table 1: Physiochemical properties of the soil sample of the experimental field.

Soil Properties	2019	2020
Particle Size distribution (g kg^{-1})		
Sand	815.5	8.17
Silt	109	110
Clay	78	77
Textural class	SL	SL
pH (1:2)		
H2O	6.7	6.8
Kcl or Cacl	5.5	6.1
Total N (g kg^{-1})	1.21	1.23
Organic C (g kg^{-1})	4.5	4.51
Available P (mg kg^{-1})	8.25	8.50
Exchangeable bases (C mol kg^{-1})		
Ca2+	3.75	3.85
Mg2+	3	2.90
k+	0.07	0.03
Na+	0.17	1.55
Exchangeable acidity (C mol kg^{-1})		
Al3+ H+	0.8	0.70
ECEC	8.2	7.69

Table 2: Effect of nitrogen rates on days to first flower bud site, opening and 50 % Flowering of two okra varieties in 2019 and 2020

	First flower bud site		First lower bud opening		50 % flowering	
	2019	2020	2019	2020	2019	2020
Variety (V)						
NHAe47-4	60.0a	63.87a	72.0b	73.93a	84.0a	86.67a
LD 88	59.0b	63.73a	74.0a	73.67a	84.0a	83.80a
LSD (0.05)	1.72	2.08	2.41	2.27	3.58	3.87
Nitrogen rate						
0	61.0a	65.17a	71.0b	75.50a	88.0a	88.00a
30	62.0a	63.33a	73.0ab	73.33a	86.0a	88.00a
60	58.0bc	63.00a	72.0ab	72.50a	78.0b	81.50b
90	60.0ab	63.50a	73.0ab	73.67a	81.0b	83.17ab
120	57.0c	64.00a	75.0a	74.00a	87.0a	85.50ab
LSD (0.05)	2.72	3.28	3.80	3.40	5.66	6.12
Interaction						
V x N	NS	NS	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Plant height

The effect of nitrogen rates on plant height of two okra varieties at different stages of growth in 2019 and 2020 is shown in Table 4. Variety affected all the triats in both cropping seasons except at maturity in 2020. At 4 WAS, LD 88 produced taller plants (10.55 cm) than NHAe47 – 4 which produced the shortest plants (8.96 cm). In 2020, NHAe47 – 4 produced the tallest plants (8.96 cm) than LD 88 which had the shortest (7.61 cm). At first flower bud site, the variety LD 88 consistently produced the tallest plants (49.13 and 45.29 cm) the NHAe47 – 4 which consistently produced the shortest plants (38.18 and 42.27 cm) in both years respectively. At first flower bud opening and 50 % flowering in 2019, NHAe47 – 4 produced taller plants (60.12 cm) and (84.98 cm) than LD 88 which had the lowest (55.63 cm) and (75.14 cm). In 2020, LD 88 produced the taller plants (74.22 cm) than NHAe47 – 4 which produced the shortest plants (57.69 cm) (78.75 cm). At maturity in 2019, LD 88 produced taller plants (104.85 cm) than NHAe47 – 4 which produced the shortest plants (89.91 cm).

Nitrogen rates had a significant effect on plant height in this study except at first flower bud opening, 50 % flowering and at maturity in 2020. At 4 WAS in 2019, the application of 90 and 120 kg N ha-1 recorded significantly similar tallest plants (10.48 and 10.52 cm) than the application of 0, 30 and 60 kg N ha-1 which recorded statistically similar shortest plants (8.90, 9.18 and 9.25 cm). In 2020, zero application recorded taller plants (9.28 cm) which was statistically similar with the applications of 30, 60 and 90 kg N ha-1 compared with the application of 120 kg N ha-1 which had the shortest plants (7.70 cm). At first flower bud site in both years, the application of 120 kg N ha-1 consistently recorded significantly taller plants (51.28 and 53.20 cm) than all the other nitrogen application rates compared with zero application which consistently recorded the shortest plants (36.15 and 38.42 cm) in 2019 and 2020 respectively.

At first flower bud opening in 2019, all the plots with nitrogen application produced similar tallest plants than zero application which recorded the shortest plants. At 50 % flowering in 2019, the application of 120 kg N ha-1 produced taller plants (87.73 cm) than all the other rates which recorded statistically similar shortest plants. At maturity in 2019, the application of 120 kg N ha-1 produced significantly taller plants (115.50 cm) than the other rates compared with zero application which recorded the shortest plants (65.77 cm).

Number of productive branches

The effect of nitrogen rates on number of productive branches of two okra varieties in 2019 and 2020 is shown in Table 5. Number of productive branches was not significantly different among the varieties in both years in this study.

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Table 3: Effect of nitrogen rate on number of leaves of okra varieties at different maturity periods in 2019 and 2020

	Number of leaves									
	At 4 WAS		Flower bud site		Flower bud opening		50 % flowering		At maturity	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Variety (V)										
NHAe47-4	6.0a	4.73a	12.0a	9.60b	12.0b	15.00a	19.0a	16.00a	3.0b	4.00a
LD 88	7.0a	4.87a	12.0a	10.33a	14.0a	14.73a	20.0a	17.27a	4.0a	4.13a
LSD (0.05)	1.03	0.46	0.60	0.36	0.62	1.46	1.27	2.01	0.49	0.35
Nitrogen rate										
0	5.50c	4.67a	12.0a	9.50b	12.0c	13.17b	17.0b	14.00b	3.0a	3.33c
30	6.83abc	4.50a	12.0a	9.83b	13.0bc	14.67b	19.0a	16.67ab	4.0a	4.33ab
60	7.67a	4.83a	12.0a	10.00ab	13.0bc	14.67b	19.0a	17.17ab	3.0a	4.83a
90	7.50ab	5.17a	12.0a	10.00ab	13.3ab	14.83ab	21.0a	17.67a	4.0a	3.83bc
120	6.00bc	4.83a	12.0a	10.50a	14.2a	17.00a	21.0a	17.67a	4.0a	4.00b
LSD (0.05)	1.63	0.73	0.95	0.58	0.98	2.31	2.01	3.17	1.78	0.56
Interaction										
V x N	NS	NS	NS	NS	NS	**	NS	NS	*	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Table 4: Effect of nitrogen rate on plant height of okra varieties at different maturity periods in 2019 and 2020

	Plant height (cm)									
	At 4 WAS		Flower bud site		Flower bud opening		50 % flowering		At maturity	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
Variety (V)										
NHAe47-4	8.78b	8.96a	38.18b	42.27b	60.12a	57.69b	84.98a	78.75b	89.91b	92.58a
LD 88	10.55a	7.61b	49.13a	45.29a	55.63b	74.22a	75.14b	94.25a	104.85a	173.21a
LSD (0.05)	0.77	0.96	2.20	0.58	3.13	8.78	4.74	11.35	7.99	141.67
Nitrogen rate										
0	8.90b	9.28a	36.15d	38.42e	51.42b	63.47a	73.83b	82.53a	65.77d	89.90a
30	9.18b	8.27ab	40.33c	39.82d	59.33a	68.48a	78.72b	93.70a	89.60c	102.10a
60	9.25b	8.22ab	46.43b	40.87c	58.82a	67.10a	80.83ab	83.08a	113.60ab	101.00a
90	10.48a	7.97ab	45.65b	46.60b	58.05ak	66.18a	79.18b	80.25a	102.45b	94.20a
120	10.52a	7.70b	51.28a	53.20a	61.75a	64.55a	87.73a	92.93a	115.50a	277.30a
LSD (0.05)	1.22	1.52	3.49	0.91	4.95	13.89	74.49	17.95	12.64	223.99
Interaction										
V x N	*	NS	NS	**	NS	NS	NS	NS	NS	NS

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Table 5: Effect of nitrogen rates on number of productive branches and abortion Incidence of two okra varieties in 2019 and 2020

	Number of productive branches		Abortion incidence	
	2019	2020	2019	2020
Variety (V)				
NHAe47-4	4.0a	3.67a	2.40a	2.20a
LD 88	4.0a	3.53a	2.27a	2.53a
LSD (0.05)	0.87	0.45	0.86	0.44
Nitrogen rate				
0	2.0c	2.83c	2.00a	3.50a
30	4.0b	2.83c	2.33a	2.67b
60	5.0a	3.67b	2.83a	1.83c
90	5.0a	4.17ab	2.00a	1.67c
120	5.0a	4.50a	2.50a	2.17bc
LSD (0.05)	1.38	0.70	1.36	0.70
Interaction				
V x N	NS	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

Table 6: Effect of nitrogen rates on number of fresh fruits and number of seed of two okra varieties in 2019 and 2020

	Number of fresh Fruit		Number of seed	
	2019	2020	2019	2020
Variety (V)				
NHAe47-4	17.00a	12.87b	59.0a	74.66a
LD 88	18.47a	16.80a	62.0a	70.73a
LSD (0.05)	3.36	1.56	4.41	6.85
Nitrogen rate				
0	14.00b	8.17c	44.0c	36.83d
30	13.33b	9.17c	50.0c	49.83c
60	19.50a	16.83b	62.0b	84.50b
90	21.67a	18.33b	69.0a	92.17ab
120	20.17a	21.67a	75.0a	100.17a
LSD (0.05)	3.73	2.40	6.97	10.83
Interaction				
V x N	*	**	NS	NS

Means with the s ame letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD.

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Fresh fruit weight

The effect of nitrogen rates on fresh fruit weight of two okra varieties in 2019 and 2020 is shown in Table 7. Fresh fruit weight differed significantly among the varieties in 2020 only. LD 88 produced the heaviest fresh fruits (585.29 g) than NHAe47 – 4 which had the lightest fresh fruits (450.61 g).

Nitrogen rates had a significant effect on fresh fruit weight in both years. In 2019, the application

of 60, 90 and 120 kg N ha-1 produced significantly heaviest fresh fruits (630.18, 726.77 and 677.57 g) than 0 and 30 kg N ha-1 which recorded similar lightest fresh fruits (273.53 and 381.80 g).

Weight of seed

The effect of nitrogen rates on weight of seed of two okra varieties in 2019 and 2020 is shown in Table 7. Weight of seed was not significantly different among the varieties in 2019 and 2020.

Nitrogen rates affected weight of seed significantly across the years. In 2019, application of 120 kg N ha-1 produced heavier seeds (6.25 g) than the other rates compared with 0 and 30 kg N ha-1 which had similar lightest seeds (3.03 and 3.80 g). In 2020, the application of 90 and 120 kg N ha-1 produced significantly similar heaviest seeds (5.61 and 6.12 g) than the other rates compared with zero application which produced the lightest seeds (1.53 g).

Weight of 100 seed

The effect of nitrogen rates on 100 seed weight of two okra varieties in 2019 and 2020 is shown in Table 7. 100 seed weight was significantly different among the varieties in 2019. The variety LD 88 produced the heaviest 100 seeds (5.23 g) than NHAe47 – 4 which produced the lightest 100 seeds (3.90 g).

Nitrogen rates had a significant effect on 100 seed weight in both years. In 2019, the application of 120 kg N ha-1 produced significantly heavier 100 seeds (7.20 g) than the other rates compared with zero application which produced the lightest 100 seeds (3.07 g) which was statistically similar with the application of 30 and 60 kg N ha-1. In 2020, the application of 90 and 120 kg N ha-1 produced statistically similar heaviest 100 seeds (6.59 and 7.26 g) than application of 60 kg N ha-1 compared with the 0 and 30 kg N ha-1 which recorded similar lightest 100 seeds (2.35 and 2.99 g).

4.DISCUSSION

Fertilizer application is an important aspect of field crop management which is needed to enhance plant growth, fruit and seed yield. The variations observed between the two okra varieties in terms of the evaluated parameters may be due to genetic quality. Maintaining optimum plant population and nitrogen fertilization dose are most important elements in improving productivity of okra.

Table 7: Effect of nitrogen rates on fresh fruit weight, weight of seed and weight of 100 seed of two okra varieties in 2019 and 2020

	Fresh fruit weight		Weight of seed		Weight of 100 seed	
	2019	2020	2019	2020	2019	2020
Variety (V)						
NHAe47-4	540.11a	450.61b	4.43a	3.89a	3.90b	4.54a
LD 88	602.86a	585.29a	4.57a	3.92a	5.23a	4.86a
LSD (0.05)	92.56	76.39	0.28	0.40	0.88	0.70
Nitrogen rate						
0	413.22b	273.53c	3.03d	1.53d	3.07c	2.35c
30	409.68b	381.80c	3.80d	2.23c	3.93bc	2.99c
60	630.18a	507.47b	4.29c	4.05b	3.87bc	4.32b
90	726.77a	697.03a	5.64b	5.61a	4.75b	6.59a
120	677.57a	729.93a	6.25a	6.12a	7.20a	7.26a
LSD (0.05)	146.35	120.78	0.44	0.64	1.39	1.11
Interaction						
V x N	**	**	**	NS	NS	NS

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by LSD

Optimum plant density is the key element for higher fruit yield of okra, as plant growth and yield are affected by nitrogen fertilization (Khan et al., 2013). Olaniyi et al. (2010) stated that the use of extra N on vigorous plants as the practice may result in plants producing heavy foliage which will delay flowering. Daram and Kumar (2013) reported that higher rates (90 and 120kg ha-1) of N resulted in significant delay in flowering and reduced fruiting of egg plants compared to plants of control, 20 and 40 kg ha-1 of N. The delay in flower bud sighting, subsequent opening and attainment of 50% flowering recorded in the two varieties that were fertilized with 100 and 120kg ha-1 of N in this study is an indication that N at those rates were relatively high. This agrees with the results of Musa et al. (2010) who reported similar rates in eggplant. The increase in plant height, as a result of the application of inorganic fertilizer at different levels, might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth giving rise to the observed tall plants recorded in the present study (Zubairu et al. 2017). In zero N dose plots which recorded minimum plant height might be due to the meager nutritional standing which resulted in stunted growth resulting in short plants. Muhammed et al. (2013) recorded similar result in their experiment conducted to evaluate the influence of nitrogen and phosphorous fertilizer on the phenology of okra. Similar trend was also obtained by Oladiran et al., (2016) who recorded maximum plant height with application of 120 kg N.

Arain et al. (2011) reported that differences in genetic makeup may be responsible for variations in fruit and seed yield under given set of environmental condition. The unfertilized plants (control) in all the traits recorded poor performance due to poor plant nutrition. The performance of okra is determined largely by application of fertilizers (Olaniyi et al., 2005). Olaniyi et al., 2010 stressed that adequate supply of nitrogen is essential for vigorous vegetative growth and optimum yield.

The seed maturation however, is closely associated with fruit maturation and complete fruit drying (McAtee et al., 2013). The suitable stage of harvest could also vary from cultivar to cultivar. For most crop species, the more matured the fruit is at harvest, the higher the quality of its seeds (Rumi et al., 2010). Wulff (1986) also reported that different seeds within a fruit do not mature at the same rate. This therefore suggests that the different seeds contained in a fruit are of different ages and therefore of varying qualities.

A study conducted by (Seal et al., 2013) noted that there is a positive linear correlation between fruit weight and seed dry weight on kiwifruit. They stated that flowers that open earlier have a larger ovary and set larger seeds leading to large fruits explaining that this may be because of either their innate superiority or their position on the vine.

5.CONCLUSIONS

It was concluded from this study that application of 90- 120 kg N ha-1 seems to be optimum for okra due to enhanced growth and yields. However, flowering was delayed when N was applied. Plants to which no fertilizer was applied performed poorly in respect of all parameters studied. NHAe47-4 fruits contained more number of seeds than LD88 variety. However, application of 90kg N/ha to okra is therefore suggested for good growth, improved fruit and seed yield in the studied zone.

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