IMPACT OF NITROGEN RATES ON THE SEED QUALITY OF OKRA (Abelmoschus esculentus L. Moench) VARIETIES AT DIFFERENT FRUIT POSITION

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ABSTRACT
The experiment was conducted at the Teaching and Research Farm of the Federal University of Technology Minna, during the 2019 and 2020 cropping seasons. The treatments consisted of 2x5x6 factorial combinations of two okra cultivars (NHAe47-4 and LD 88), five nitrogen rates (0, 30, 60, 90, and 120 kg ha-1) and six fruit positions on the mother-plant (1, 2, 3, 4, 5 and 6th) arranged in a Completely Randomized Design (CRD) and replicated four times. Parameters measured includes number of seeds, seed weight and germination percentage. Data collected were subjected to analysis of variance (ANOVA) using SAS Statistical package 9.2. At 5% level of probability means were separated using Least Significant Difference (LSD) Test. Application of 120 kg N ha-1 produced the highest number of seeds and seed weight of okra. Harvested fruits from the lower positions (1-2) gave best results in all the parameters. While seed germination was greater at the lower positions prior to storage and after storage.
Keywords: *Okra, Seed size, Fruit position*

INTRODUCTION

Okra (Abelmoschus esculentus (L.) Moench), an economically important vegetable crop grown in tropical and sub-tropical parts of the world, also known as Ladies' Finger, originated from Ethiopia (Pandey et al., 2017) and was then propagated in North Africa, in the Mediterranean, Arabia and India by the 12th century BC (Nimona, 2019). It is one of the most widely known and utilized species of the family Malvaceae (Dantas et al., 2021). Okra grows best on well-drained sandy loam soil; it prefers slightly acidic soils with a pH between 6.0 and 6.8 (Nisar et al., 2021). The minimum and maximum soil temperatures for growth are 20°C and 30 °C, respectively and relative humidity of 21% – 30% (Makinde, 2022).

Good seed nutrition of the mother-plant during growth is important as it has been reported (Yakubu and Abubakar, 2017) to result in rapid seedling emergence in okra varieties. The mother-plant has a significant influence over seed traits, including seed size, dormancy, germination and storage. In many species, factors such as age of the mother-plant and position of the seed in the fruit, inflorescence, or canopy can affect seed properties (Lu et al., 2017). Seed quality is also affected by several factors and seed germination, vigour and health assessment play an important role in determination of seed quality (Ndinya et al., 2020). Seed vigour is an important factor that affects seedling establishment and crop growth and ultimately production rate. The seed lot may differ in size, number and weight which may be affected by growing conditions and cultural practices (Adebisi et al., 2021). Adebisi et al. (2011) reported that seed size, number and weight are components of seed quality which affects the performance of crop. The study was carried out to determine the impacts of nitrogen rates on seed quality of okra at different fruit positions.

MATERIALS AND METHODS

A Field experiment was conducted at the Teaching and Research Farm of the Federal University of Technology, Minna (latitude 90 51 1N and longitude 60 44 1E) during the 2019 and 2020 cropping seasons (May-Sept). Before land preparation, soil samples were collected from surface (0-15cm) with an

auger from 10 points along four diagonal transects, each bulked together to give four composite samples. The soil samples were air dried and sieved through 2mm and 0.5mm sieve. They 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 as described by Agbenin (1995). Seeds of NHAe47-4 and LD 88 variety of okra were sourced from the National Horticultural Research Institute (NIHORT) Ibadan, Oyo State Nigeria.

The land was manually cleared and ploughed with a tractor and ridges were constructed manually at 75 cm apart each measuring 2 m long. Plots were measuring 2×5.25 m (10.5m2) comprising of 8 ridges. The treatments consisted of factorial combinations of two okra cultivars (NHAe47-4 and LD 88) five nitrogen rates (0, 30, 60, 90, and 120 kg ha-1) and six fruit positions on the mother-plant (1, 2, 3, 4, 5 and 6th) arranged in a Completely Randomized Design (CRD) and replicated four times. Three seeds were manually sown per hole at 0.5m apart and later thinned to one vigorous seedling per stand (2WAP). Basal application of Phosphorus using single super phosphate and muriate of potash as sources and split application of varying rates of urea as a source of N fertilizer at 50 kg ha-1 each was applied in all the plots 2 week after planting (WAP) respectively. . The first application was at 2 WAP and second application was at 4 WAP (before flowering). Weeding was carried out at two weeks intervals manually.

Incidence of insect pests was suppressed from 2WAS till harvesting stage with the application of Zap® a.i (Lambda Cyhalothrin 25g/L), at 0.005kg a.i/ha. . Plants were date tagged at flowering daily on the field. The tagged fruits were harvested at different positions on the mother-plant (1, 2, 3, 4, 5 and 6) at 42 DAA (Days after anthesis). Following each harvest, the fruits were broken to extract the seeds. The seeds were left to dry further at ambient temperature for about two weeks before storage. Samples of seeds from each treatment combinations were put in small open plastic plates measuring 300 ml and then placed in an incubator at 35 °C and relative humidity of 90 %. This was aimed at accelerating the ageing of the seeds to determine the relative longevity of the seeds of the different lots (Delouche and Baskin, 1973). The okra seed samples were drawn from the containers in storage for conducting germination test at 0, 2, and 4 weeks after storage. This was done by counting four replicates of 30 seeds of the seven harvesting stages which was placed on filter paper moistened with distill water in plastic Petri-dishes. Germination counts was taken every-other-day and results were expressed in percentages. Parameters measured included Number of seeds, seed weight and germination percentage

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 Least Significant Difference (LSD) Test.

RESULTS

The results of the chemical and physical properties of the soil at 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) of 4.50(g kg-1), 4.51(g kg-1) and Soil Total N of 1.21 (g kg-1), 1.23(g kg-1) was found to be low. The available phosphorus 8.25, 8.50 (mg kg-1) and ECEC 8.2, 7.69 (cmol+ kg-1) respectively of the soil were also found to be low. The Exchangeable bases (Cmol+ kg-1) Ca^{2+} 3.75, 3.85, K^+ 0.07, 0.03 and Na^+ 0.17, 1.55 respectively were considered to be moderate. The exchangeable Mg^{2+} 3.0, 2.90 was considered sufficient to support plant growth.

The effect of nitrogen rates on number of seed of two okra varieties at different harvesting positions in 2019 and 2020 is shown in Table 2. Number of seed was significantly different among the okra varieties at harvesting position 1 in 2020 only, such that LD 88 produced the highest number of seed (72.47) than NHAe47 – 4 which produced the lowest number of seed (68.0). Nitrogen rates had a significant effect on number of seed throughout the sampling positions in 2019 and 2020 respectively. At position 1, the application of 120 kg N ha-1 produced the highest number of seed in both years (88.33 and 87.50) than the other rates compared with zero application in 2019 (39.88), 0 and 30 kg N ha-1 in 2020 (51.83 and

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58.00) which produced the lowest number of seeds. At position 2 in 2019, the application of 60, 90 and 120 kg N ha-1 produced significantly similar highest number of seeds (62.50, 67.67 and 65.33) than zero application which had the lowest number of seed (38.83). In 2020, the application of 90 and 120 kg N ha-1 produced statistically similar highest number of seed (69.17 and 75.33) than the application of 60 kg N ha-1 (62.17) compared with 0 and 30 kg N ha-1 which recorded similar lowest number of seed (44.17 and 50.17). At position 3 in 2019, the application of 90 and 120 kg N ha-1 produced similar highest number of seed (69.17 and 75.33) compared with 0 and 30 kg N ha-1 which had similar lowest number of seed (44.2 and 50.2).

The effect of nitrogen rates on seed weight of two okra varieties at different harvesting positions in 2019 and 2020 are shown in Table 3. Seed weight differed significantly across the positions and years except at position 1 in 2019, position 4 and 5 in both years and position 6 in 2020 which showed no significant difference among the varieties. The variety LD 88 consistently produced the heaviest seeds between (3 g – 5 g) than NHAe47 – 4 which consistently produced the lightest seeds between (3 g – 4 g) across the years. Nitrogen rates affected seed weight significantly throughout the sampling periods in 2019 and 2020 respectively. At position 1, the application of 120 kg N ha-1 produced significantly heavier seeds in both years (6.25 g and 6.07 g) than the other rates compared with zero application in 2019 (3.03 g), application of 0 and 30 kg N ha-1 in 2020 (4.09 g and 4.3 g) which produced the lightest seeds. At position 2 in 2019, the application of 60, 90 and 120 kg N ha-1 produced statistically similar heaviest seeds (4.45 g, 4.65 g and 4.59 g) than zero application which had the lightest (3.22 g). In 2020, the application of 120 kg N ha-1 produced significantly heavier seeds (5.11 g) similar with the application of 90 kg N ha-1 (4.18 g) compared with 0 and 30 kg N ha-1 which had similar lightest seeds (3.66 g and 3.88 g).

Table 4 showed variety significantly affected germination percentage of seeds at different storage periods at 0 weeks before storage (WAS). Seeds of NHAe47-4 germinated significantly higher 49.57% than LD88 43.50 % in 2019 while in 2020 LD88 recorded 54.25%) than seeds of NHAe47-4 51.61%. In 2019, at 2 WAS varieties significantly differed statistically in both years respectively. NHAe47-4 recorded higher germination 46.25% than LD88 39.02%. While in 2020 the reverse was recorded where LD88 germinated significantly higher with 35.92% than NHAe47-4 32.89%. The same trend affected the traits significantly at 4WAS. However, position affected germination percentages significantly across storage periods. Prior to storage, seeds extracted from fruits of positions 1 and 2 germinated significantly higher (61.50% and 58.85%) than those of positions 3-6 with values ranging between 50.40 and 27.90% in 2019. In 2020, seeds from positions 4 and 3 germinated significantly higher 77.47 and 76.03%.

DISCUSSION

Rao et al. (2017) advised that seeds should be harvested at appropriate time to ensure their quality in terms of germinability and vigour. However, Bortey et al. (2022) reported that fruits harvested even before physiological maturity and allowed some days of post-harvest ripening may produce good quality seeds since seed development continues in fleshy fruits owing to continuous supply of nutrients and food reserves from fruit to seed. Kortse and Oketa (2016) also observed that okra fruit size was affected by position on mother-plant under competition for assimilates. Seeds from the peduncular fruit segments were delayed in reaching maximum quality compared with seeds from other positions in cucumber (Hu et al., 2019). Bigger seeds in the earlier positions than in later ones (position 6) is due to the fact that less nutrients were made available to the developing fruits and seeds of later positions (Ibrahim and Oladiran, 2011). Position 1 fruits weighed the heaviest compared to those of the other positions (2, 4, 4, 5 and 6) on the mother-plant, this result agrees with the trend reported by Alan and Eser (2007) for pepper in which fruit weight gradually declined from position closest to the plant base to those at the upper layer.

CONCLUSION

Fruits formed at the lower positions (1-3) produced more and bigger seeds than those formed at the higher positions (4-6).

Position of fruits on the mother-plant

Table 1: Physical and chemical properties of the soil samples 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)		
H_2O	6.7	6.8
Kcl or $Cacl_2$	5.5	6.1
Total N (g kg^{-1})	1.21	1.23
Organic C (g kg^{-1})	4.50	4.51
Available P (mg kg^{-1})	8.25	8.50
Exchangeable bases (Cmol^{+} kg^{-1})		
Ca^{2+}	3.75	3.85
Mg^{2+}	3.00	2.90
K^{+}	0.07	0.03
Na^{+}	0.17	1.55
Exchangeable acidity (Cmol kg^{-1})		
Al^{3+} H^{+}	0.8	0.70
ECEC	8.2	7.69

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Table 2: Effect of nitrogen rate on number of seed of okra varieties at different plant positions

	Number of seed											
	Position 1		Position 2		Position 3		Position 4		Position 5		Position 6	
Variety (V)	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
NHAe47-4	63.13a	68.00b	56.53a	58.73a	58.73a	56.53a	40.67a	50.07a	63.13a	40.67a	45.87a	38.20a
LD 88	63.20a	72.47a	58.73a	61.67a	61.67a	58.73a	38.53a	51.53a	64.20a	38.53a	42.93a	39.33a
LSD (0.05)	3.41	3.99	4.78	4.41	4.41	4.78	5.03	5.44	3.41	5.03	6.17	5.52
N (kg ha^{-1})												
0	39.83e	51.83d	38.83c	44.17c	44.17c	38.83c	30.00c	33.00c	39.83e	30.00c	38.83a	30.33b
30	48.67d	58.00d	53.83b	50.17c	50.17c	53.83b	34.33bc	41.00c	48.67d	34.33bc	44.00a	36.17ab
60	60.33c	72.67c	62.50a	62.17b	62.17b	62.50a	41.50b	50.83b	60.33c	41.50b	45.67a	41.83a
90	81.17b	81.17b	67.67a	69.17a	69.17a	67.67a	41.83b	67.67a	81.17b	41.83b	47.67a	41.67a
120	88.33a	87.50a	65.33a	75.33a	75.33a	65.33a	50.33a	61.50a	88.33a	50.33a	45.83a	43.83a
LSD (0.05)	5.39	6.30	7.55	6.97	6.97	7.55	7.96	8.66	5.40	7.96	9.75	8.73
Interaction												
V x N	**	NS	NS	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 3: Effect of nitrogen rate on seed weight of okra varieties at different plant positions

	Seed weight (g)											
	Position 1		Position 2		Position 3		Position 4		Position 5		Position 6	
Variety (V)	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
NHAe47-4	4.63a	4.80b	4.05b	4.22b	4.22b	4.05b	3.05a	3.60a	3.09a	3.05a	4.05b	2.91a
LD 88	4.57a	5.21a	4.30a	4.53a	4.53a	4.30a	3.17a	3.88a	3.14a	3.18a	4.30a	2.91a
LSD (0.05)	0.28	0.22	0.24	0.28	0.28	0.24	0.30	0.30	0.46	0.29	0.24	0.31
N (kg ha^{-1})												
0	3.03c	4.09d	3.22c	3.66c	3.66c	3.22c	2.52c	2.62c	3.03ab	2.52c	3.22c	2.40c
30	3.79d	4.31d	3.97b	3.88c	3.88c	3.97b	2.83bc	3.43b	3.55a	2.83bc	3.97b	2.76c
60	4.29c	5.01c	4.45a	4.42b	4.42b	4.45a	3.35a	3.70b	2.93ab	3.36a	4.45a	2.93ab
90	5.64b	5.54b	4.65a	4.81ab	4.81ab	4.65a	3.23ab	4.63a	3.43a	3.23ab	4.65a	3.11ab
120	6.25a	6.07a	4.59a	5.11a	5.11a	4.59a	3.63a	4.33a	2.60b	3.63a	4.59a	3.35a
LSD (0.05)	0.44	0.35	0.38	0.44	0.44	0.38	0.47	0.48	0.73	0.47	0.38	0.49
Interaction												
V x N	**	NS	NS	NS	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: The effect of fruit position on mother-plant on the germination percentage of seeds of two okra varieties at different storage periods

	Week 0		Week2		Week 4	
Variety (V)	2019	2020	2019	2020	2019	2020
NHAe47-4	49.57a	51.61b	46.25a	32.89b	33.60a	34.54b
LD 88	43.50b	54.25a	39.02b	35.92a	32.12a	35.86a
LSD (0.05)	1.71	2.13	0.71	0.40	1.21	0.70

Table 4: The effect of fruit position on mother-plant on the germination percentage of seeds of two okra varieties at different storage periods

	Week 0		Week2		Week 4	
Variety (V)	2019	2020	2019	2020	2019	2020
NHAe47-4	49.57a	51.61b	46.25a	32.89b	33.60a	34.54b
LD 88	43.50b	54.25a	39.02b	35.92a	32.12a	35.86a
LSD (0.05)	1.71	2.13	0.71	0.40	1.21	0.70
Positions (P)						
1	61.50a	59.25b	54.30a	50.25ab	5015a	40.23b
2	58.85a	54.93b	57.25a	59.34a	44.90b	41.32a
3	50.40b	76.03a	47.65b	41.21b	35.50c	30.59c
4	45.10c	77.47a	43.60c	39.05c	34.50c	29.23c
5	35.45d	39.80c	30.30d	22.23d	15.50d	20.99d
6	27.90e	25.53d	22.70e	20.53e	16.55d	14.35e
LSD (0.05)	2.22	2.24	1.22	3.64	1.02	1.11
Interaction						
V x P	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.

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