INTERNATIONAL JOURNAL OF PRECISION FARMING (IJPF)

ISSN: 2995-1143 (ONLINE)

VOLUME 2 ISSUE 1 (2024)

PUBLISHED BY
E-PALLI PUBLISHERS, DELAWARE, USA

International Journal of Precision Farming (IJPF)

Volume 2 Issue 1, Year 2024
ISSN: 2995-1143 (Online)
DOI: https://doi.org/10.54536/ijpf.v2i1.3225
https://journals.e-palli.com/home/index.php/ijpf

Evaluation of Five Sesame (*Sesamum Indicum L.*) Varieties Under Varying Fertilizer Rates and Establishment Methods for Growth and Yield in Anyigba, Kogi State, Nigeria

Yusuf, M.[1]*, U. T. Musa[2]

Article Information

Received: July 23, 2024

Accepted: August 20, 2024

Published: September 09, 2024

Keywords

Establishment Method, Fertilizer Rates, Growth, Sesame, Varieties And Yield Attributes

ABSTRACT

Global sesame seed market is projected to have USD 7.24 billion in consumption value by 2024. However, its supply has not been able to match the demand due to several constraints to its production. This study was conducted at the Prince Abubakar Audu University Research and Demonstration Farm, during the 2023 cropping season to evaluate five sesame varieties for growth and yield under varying fertilizer rates and establishment methods. Treatment consisted of five sesame varieties, two establishment methods, and three fertilizer levels respectively combined factorially to obtain a total of thirty factorial treatment combinations and laid out in a Randomized Complete Block Design (RCBD) with three replicates. Results showed that varieties differed significantly ($P < 0.05$) in growth, yield and yield characters. YANDEV55 produced the widest leaf area at 9WAS, NCRIBEN-02M produced the highest number of leaves per plant (36) at 12WAS. The same variety (NCRIBEN-02M) consistently produced the tallest stems (42.48, 56.10, 80.48 & 93.46 cm) at 3, 6, 9 & 12WAS. YANDEV55 produced 73.6 % germination which was highest amongst others. E8 produced the highest number of capsule/plant (23.3) and number of seeds/plant (1428.94). NCRIBEN-05E performed optimally in yield characters such as total plant biomass yield (2908.0g/plot) and final seed yield (887.9kgha^{-1}). NCRIBEN-02M had the highest haulm yield (33.0g/plot) while NCRIBEN-01M had the longest days (54.16) to 50% anthesis. Seed/capsule and Harvest index were not significantly affected by varieties. Broadcast method produced significantly widest leaf areas of 53.9 and 40.5 cm^2 at 6 and 12 WAS respectively, higher number of leaves (18.0) at 3WAS. Drilling method of crop establishment produced the highest biomass yield (2894.6g/plot) and final seed yield (879.2 kgha^{-1}). Similarly, fertilizer rates affect growth and yield characters; 100 kg NPKha^{-1} produced the widest leaf area, tallest plants and highest number of leaves/plant at all stages of sampling. These were at par with values obtained when plots were treated with 150kg NPKha^{-1}. Alternatively, highest number of capsules/plant (22.4), seeds/capsule (62.46), seeds/plant (1502.73), total plant biomass yield (2879.7g/plot), haulm yield (33.0g/plot), final seed yield (870.7kgha^{-1}) and longest number of days to 50% anthesis (53.6) were all obtained when plots were treated with 150 kgha^{-1} but was at par with 100kg NPKha^{-1}. Fertilizer rates did not affect the establishment count and harvest index. The best variety with respect to yield/ha is NCRIBEN-02M, Application of 100 kg NPK/ha appears maximum for optimum yield of the crop, drilling appears to produce higher yield than broadcast for some varieties with an overall marginal increase of 8.4 % over broadcast and thus recommended for Anyigba environment. An economic study of the cost implication for both operations (drilling and broadcast) could be embarked upon to ascertain the veracity of this assertion, more so that broadcast requires higher seed rate than drilling. Significant interaction of varieties x establishment method was also an indication that very high yielding varieties (NCRIBEN-02M and NCRIBEN-01M) do better when drilled compared to broadcast. Significant positive relationship between some growth, yield and yield characters is an indication that effective crop improvement through selection can be carried out by selecting for those characters that correlated positively with yield.

INTRODUCTION

Sesame (*Sesamum indicum L.*) is one of the ancient crops known to mankind (NCRI, 2002; Langham *et al.*, 2008). It is the most important and useful oil-seed tropical and sub-tropical crop grown in over 20 countries around the world (Madina, 2020). Its' an annual flowering plant belonging to the family Pedaliaceae, and the genus Sesamum (Purseglove, 1974) consist of about 36 species of which 19 species are indigenous to Africa. The origin of sesame is immemorially obscure, as reported by Bedigian 2003a; 2003b, sesame may have originated from Africa, Indian subcontinent. Africa is the host of all the wild species, similarly, the prospect of sesame in the economy of several African countries justify African continent as the ultimate Centre of origin (Dudley *et al.*, 2000). The crop has originally received less research attention in Nigeria (Usman *et al.*, 2021), because it was introduced after world war II and cultivated as a minor crop in the Northern and Central Nigeria until 1974 when it began to gain prominence as a major crop (Madina, 2020).

Today, sesame crop is cultivated in almost all tropical and subtropical Asian and African Countries at latitudes 40° North and South. The tropical annual *Sesamum indicum* is grown for its seeds which are highly nutritious and edible

[1] Department of Agricultural Technology, Kogi State Polytechnic PMB 1101, Lokoja, Kogi State, Nigeria
[2] Department of Crop Production, Prince Abubakar Audu University, PMB 1008, Anyigba, Kogi State, Nigeria
* Corresponding author's e-mail: momohjimohyusuf@kogistatepolytechnic.edu.ng

(Iwo, *et al.*, 2002). As reported by Islam *et al.*, (2016), Gharby *et al.*, (2017) and Madina (2020), sesame seeds are high in fat (50 - 60%), protein (18 – 25%), carbohydrates (13 – 14%), fiber and other essential minerals, highly valued for nutritional and medicinal purposes. The great anti-oxidant properties of sesame oil (Iwo *et al.*, 2002; Uzun *et al.*, 2012) have earned it sixth and twelfth position in the global oil seeds and vegetable oil production, respectively. The seeds are valuable ingredients in soup making because of its high oil content which plays an important role in the metabolism and the synthesis of prostaglandins (Mahmoud *et al.*, 2020). It is also used for cooking, soap and candy making, baking, as lubricant in body massage, hair treatment, food manufacture, industrial uses and alternative medicine for blood pressure, aging, stress and tension (Biswas *et al.*, 2001; Ahmed *et al.*, 2009).

As reported by Tridge (2020), global sesame seed production is led by Sudan, Myanmar, India, Nigeria, and Tanzania. Sudan has reported exceedingly high levels of production (981, 000 MT), while Myanmar produced 768, 850 MT, ranking second-largest producer as reflected in the list of high-producing countries. In 2018, 59.4% of total sesame production came from Africa while 37.5% from Asian continent (FAOSTAT 2018). This is opposed to the estimated annual production of 3.15 MT during the year 2001 (FAOSTAT 2001) haven risen from 1.4 MT in the early 1960's where China and India were the largest producers each with an annual harvest up to 750,000 MT followed by Myanmar (425,000 MT) and Sudan (300,000 MT). Global production of sesame in 2013 according to FAOSTAT (2013) was 4,756,752 MT, Africa contributed 2,117,585 MT and Nigeria contributed 165,000 MT. Today, sesame is an integral component of Nigeria's Agricultural exports produce. Given its current scale of cultivation, sesame according to USAID (2002) is the third largest export commodity in Nigeria after petroleum and cocoa with annual exportation worth 20 million U.S. dollars. In the first quarter of year 2023, the Federal Government of Nigeria recorded $49 billion from exporting its seeds (The Exchange, 2024). According to an evaluation from Mordor Intelligence (Tridge, 2020), the global sesame seed market is projected to have USD 7.24 billion in consumption value by 2024 compared to the USD 6.56 billion in 2018, carrying a CAGR of 1.7%. Statistics from the Exchange (African Investment Gateway) in 2024 showed that Nigeria has the potential to become number one global producer of sesame seed in the quest to meet its global demand. The global sesame seeds demand for the commodity is on the increase, and expected to grow at a 4.2 per cent compound yearly rate (CAGR) between 2018 and 2024. Large-scale commercial production of sesame is limited in Nigeria and there are no accurate records of National production.

Due to its' high export value, low yield (300 – 500 kg/ha) resulting from local cultivars, dearth of information on nutrient requirement, adaptation constraints, management practices and crop factor (Okpara *et al.* 2007). The National Cereal Research Institute (NCRI) introduced varieties of high yield potential in order to meet both local and export demand. Despite these improvement, the production is still low and does not cater for the geometrically growing population in the country and not meeting global demand. Imoloame *et al.* (2007) reported that the use of inappropriate sowing method and obsolete cultivars, lack of technical know-how of the improve agronomic practices and nutrient requirement (Shehu *et al.*, 2009), are the other major cause of low sesame yield in Nigeria, improved cultivars can yield 15 – 40% more than local cultivars when sown under better planting methods.

Giving the high cost of production inputs especially seeds, research into identifying establishment methods that will lead to reduction in seed rates without necessarily reducing yield should be a noble one. Most farmers in Nigeria, particularly in the Igala speaking area of Kogi State establish sesame mostly by broadcast methods and do not apply mineral fertilizers deliberately to the crop. This may be unconnected with the fact that, the crop is usually sown late in the season and in most cases in-relay with cereals. This means that the crop would inadvertently receive residual dose of mineral fertilizer applied to the first or previous crop. It is important to know however that this may not happen when the crop is not grown in relay, fertilized in relay with crops that were not previously fertilized with mineral nutrients. It is a general knowledge in Agronomy that crop varieties responds differently to applied nutrients. Identifying varieties with specific fertilizer levels will not only maximize cost of production, but more importantly re-direct research to making "Production-Domain-Recommendation"

This research therefore evaluates five varieties of sesame under varying levels of NPK fertilization and sowing methods for growth and seed yield parameters.

MATERIALS AND METHODS

Study Area

The study was conducted during the cropping season of 2023/2024 at Prince Abubakar Audu University (PAAU) Student Research Farm, Anyigba, Kogi State (Lat. 7° 29'N and Long 7° 11'E) on elevation of 420 m above sea-level. Average rainfall is 180mm distributed between April and October, mean monthly min. and max. temperature is 17° C and 36.2° C, soil is generally sandy to sandy – loam (Amhakhian *et al.*, 2012).

Soil sampling and land preparation

Samples of soil was taken from randomly selected points at depths (0 - 30cm) on the research field using tabular auger and bulked. It was analyzed for physical and chemical properties such as % clay, silt and sand. % organic carbon, total Nitrogen, available P, exchangeable bases, Cation Exchange Capacity (CEC) and soil pH as described by Bray and Kurtz, 1945; Day 1965; Black, 1965; IITA, 1975; Bremer and Malvaney, 1982. Experimental site was ploughed, harrowed, because of the nature of the experiment i.e. establishment method, soil beds were manually raised to a depth which physically supported the crop for optimum performance and reduce variability within replication.

Treatment and Experimental Design

Sesame varieties was obtained from the National Cereal Research Institute (NCRI) Badeggi, Niger State, Nigeria. The treatments used in this study consisted of five sesame cultivars; NCRIBEN-01M, NCRIBEN-02M, NCRIBEN-05E, YANDEV55 and E8, two establishment methods; broadcasting and drilling and three NPK 15:15:15 levels; 0 kg/ha, 100 kg/ha and 150 kg/ha merged in a factorial combination (5 x 2 x 3) to obtain a total of thirty treatments which was laid out in a Randomized Complete Block Design with three replicates giving a total of ninety plots with each plot measuring 3m x 4m (12m^2). Each replicate was splitted into two blocks of 15 plots each while each block was separated from its adjacent one by 0.5m demarcation. Each plot within a replicate was separated 0.5 m apart while each replicate was separated with a discard row of 1.0 m apart to narrow inter block variations.

NPK 15:15:15 fertilizer was obtained from Anyigba Local market. Planting was done by broadcasting and drilling methods on flat beds of 75 cm apart at seed rate of 8 kg/ha and 5 kg/ha respectively at a depth of 1.5 cm on the 15th day of September, 2023 as described by Bruno (2014). NPK 15:15:15 fertilizer was applied at 0 kg/ha, 100kg/ha and 150 kg/ha basally during planting.

Weed Control was done manually at every stage of its appearance by simple hand pulling, while inter plot weeds and discard rows were hoed. Aphids, thrips and other insect pests observed on the field were controlled with insecticide sprays (Imidacloprid 10% + Abamectin 1.8% WP mixture at 25 g/ha). Ten plants were tagged in each plot for data collection on growth characters such as; establishment count, plant height, number of leaves, leaf area. Data on yield characters and yield; days to flowering, number of capsule/plant, seeds/capsule, seed yield/plot, total seed yield, harvest index total plant biomass yield and haulm yield were determined at crop maturity and harvest.

Data Analysis

All data collected was subjected to Analysis of Variance (ANOVA) using Microcomputer Statistical Package (MSTAT) to determine significant differences among the treatments. Significantly different treatment means were subjected to the New Duncan Multiple Range (N-DMRT) as described by Duncan (1955).

RESULTS AND DISCUSSION

The result of the soil sample taken from the experimental area shows that the soil belongs to the textural class of sandy-clay-loam containing 0.88% Organic Carbon, 1.52% Organic Matter, 0.04% N, 5.36 mg/kg P, 2.31 mg/kg K (Table 1). This result indicated that the soil is suitable for sesame production however, low in major nutrient required for optimum sesame growth and yield, hence the recommended fertilizer rate suggested in this experiment.

Table 1: Physical and Chemical characteristics of soil taken from the experimental site before the establishment

Properties	**0 - 15 and 15 – 30 cm depth**
Physical	
Sand	2.28
Slit	21.20
Clay	76.52
Textural class	Sandy Clay Loam
Chemical	
PH in H_20 (1:2:5)	4.61
Organic carbon (%)	0.88
Organic matter (%)	1.52
Total Nitrogen (%)	0.04
Available phosphorus (mg/kg)	5.36
Exchangeable cation (Meq/100gm Soil)	
K+	2.31
Mg+	2.74
Ca+	4.39
Na+	0.41
CEC	10.91

Response of Sesame Growth and Yield to Variety, Fertilizer and Establishment Method

Table 2 presents the effect of varieties, fertilizer and establishment methods on establishment count and number of leaves. Varieties differ ($P \leq 0.05$) in their establishment. YANDEV55 had the highest establishment (73.66%) among all other varieties. Establishment of other varieties were at par with variety E8 having the lowest establishment. Plots established using drilling method had 65.6% establishment compared to the corresponding broadcasted plots (55.83%). Establishment counts were not significantly influenced by fertilizer rates. However, V x E, V x F, E x F and V x E x F interactions were all significant. NCRIBEN-02M consistently produced higher number of leaves than the remaining varieties throughout the sampling periods. This variety produced 36 leaves/plant at 12WAS, while the smallest number of leaves per plant (24.8) was produced by YANDEV55 at 12WAS. Establishment methods had no significant effect on the number of leaves produced/plant throughout the sampling period except at 3WAS, where broadcast plots produced plants with an average of 18.0 leaves compared with drilling of (15.8 leaves). Application of 150 kg NPK fertilizer per hectare consistently produced more leaves than control. Plots treated with 150 kg NPK/ha and 100 kg NPK/ha did not differ significantly with respect to number of leaves produced per plant. Interaction of V x E on number of leaves produced per plant was only significant at 9 and 12WAS, V x F was significant throughout the period of sampling. E x F and V x E x F were however significant at 3WAS only. The highest C.V of 35.7% was recorded for sampling periods of 9WAS for all treatments administered throughout the experiment.

NCRIBEN-02M consistently produced tallest plants (42.48, 56.10, 80.48 & 93.46 cm at 3, 6, 9 and 12 WAS respectively) throughout the period of sampling (table 3). YANDEV55 produced the shortest plants at 12WAS but was however at par with those of NCRIBEN-01M. NCRIBEN-01M and E8 varieties produced taller plants which was at par with NCRIBEN-02M at 3, 6 & 9 weeks of sampling. NCRIBEN-05E variety produced the shortest plant at 3 and 9 WAS while YANDEV55 produced the shortest plants at 6 WAS and was at par with NCRIBEN-05E. Establishment method had no significant effect on the height of the crop for the period under consideration. Plots fertilized with 150 kg NPK per hectare produced the tallest plants which were in most cases at par with plant grown on plots fertilized with 100 kg NPK/ha. Plots treated with no fertilizer consistently produced the shortest plants throughout the period of sampling. The interaction of V x E and V x F, were significant throughout the period of sampling, however, the interaction of E x F was only significant at 12WAS. V x E x F interactions were all significant throughout the period of sampling. The highest C.V of 32.4% was obtained during the 3WAS period of the experiment. NCRIBEN-02M, NCRIBEN-01M and NCRIBEN-05E consistently produced wider leaf area compared to YANDEV55 and E8. The widest leaf area of 53.8 cm^2 was produced by YANDEV55 at 9WAS. Establishment method effect on leaf area expansion was not consistent throughout the period of sampling however, broadcast method produced wider leaf area at 6 and 12WAS. Application of 150 kg NPK/ha produced the widest leaf area of beniseed, however, leaf area from plots treated with 100 and 150 kg NPK/ha appeared to be at par for all the period of sampling. Plots not treated with fertilizer performed poorly with respect to leaf area expansion. Interaction of V x F was significant throughout the sampling periods. V x E on the other hand was not significant for the period under consideration. E x F was also significant at 3WAS only. V x E x F were only significant at 3 and 6WAS only. C.Vs of 42.4, 41.6, 42.9 and 36.3% were recorded for 3, 6 9 and 12 WAS respectively (indicating the volatility of this character).

Table 4 presents the influence of varieties, fertilizer and establishment methods on days to 50% anthesis, number of capsules/plants, number of seeds/capsule, number of seeds/plant, seed yield (g/plot). NCRIBEN-01M took the longest day to 50% anthesis (54.16), this appears to be at par with NCRIBEN-05E (53.55). E8 took the lowest number of days to anthesis (51.05). Application of 100kg NPK/ha produced the longest day (53.6) to anthesis and this was at par with the control plots. E8 produced the highest number of capsules/plant (23.33) and this was at par with the NCRIBEN-01M and YANDEV55. NCRIBEN-05E produced the lowest capsules/plant and was also at par with NCRIBEN-02M. Number of Seeds/capsule were significantly not affected ($P > 0.05$) by varieties and establishment methods. The highest number of seeds/plant (1428.94) was produced by E8. NCRIBEN-05E variety produced the lowest number of seeds per plant (896.11). Establishment method had no significant effect ($P > 0.05$) on days to anthesis. However, 100kg NPK/ha produced the longest day (53.6) to anthesis and this was at par with the control plots. Similarly, Plots treated with 150kg of NPK fertilizer produced the highest number of capsules/plant, seeds/capsule and seed/plant which was at par with plots fertilized with 100 kg NPK/ha. Seed yield/plot obtained with varieties NCRIBEN-01M, NCRIBEN-02M and NCRIBEN-05E were at par. YANDEV55 produced the lowest seed yield. drilling method produced higher seed yield/plot than broadcasting. Fertilizer had no significant effect on seed yield/plot. Interaction of V x E, E x F was significant for days to 50% anthesis, number of capsules/plants, number of seeds/plant, seed yield (g/plot). Interaction of V x F was significant for all the characters aforementioned, while interaction of V x E x F was significant for others except seed yield/plot.

Table 5 presents the influence of varieties, fertilizer and establishment methods on biological yield and economic yield of sesame crop in Anyigba. The highest total biomass of 2908.0 g/plot was obtained with NCRIBEN-05E and was at par with NCRIBEN-02M, NCRIBEN-01M and E8. The least plant biomass was produced from plots grown with YANDEV55. Highest haulm yield of 33.0g was produced by NCRIBEN-02M, other varieties had higher haulm yield which were at par. YANDEV55 produced the lowest haulm yield (30.9 g/plot). Haulm yield was not affected by establishment method Plots established using drilling methods produced higher plant biomass compared with broadcast. Plots treated with 150 kg NPK/ha produced the highest plant biomass (2879.7 g/plot), haulm yield (33.0 g/plot) compared with the least values obtained in control plots. Alternatively, Harvest index values for establishment methods, fertilizer rates were not significant throughout the period of the experiment. NCRIBEN-05E produced the highest seed yield (887.9 $kgha^{-1}$) and this did not differ significantly from yield obtained with NCRIBEN-01M, NCRIBEN-02M and E8. YANDEV55 though produced the lowest seed yield/ha but appeared to be at par with E8. Plots established using drilling method produced highest yield (879.2 $kgha^{-1}$) when compared with plots established using broadcast method (811.6 $kgha^{-1}$). Plots treated with 150 kg NPK/ha also produced the highest yield when compared with those treated with 100 kg NPK/ha. However, these values were at par. Interaction of V x E, V x F and E x F were all significant at 5% level of test for total plant biomass yield and final seed yield/ha. However, the differential behavior of V x E x F as regards plant biomass and final seed yield were not significant for this experiment.

Table 2: Establishment count of five sesame varieties (*Sesamum indicum L.*) as Influenced by varying NPK rates and establishment methods in Anyigba, during the 2023 cropping season

Treatments	Establishment count	Number of leaves/plant across sampling periods			
		3 weeks	6 weeks	9 weeks	12 weeks
Varieties (V)					
NCRIBEN-01M	55.33[b]	19.5[a]	23.0[a]	38.6[a]	33.1[ab]
NCRIBEN-02M	60.67[b]	19.8[a]	24.6[a]	34.8[ab]	36.2[a]
NCRIBEN-05E	57.91[b]	14.5[b]	18.3[b]	26.7[c]	26.7[bc]
YANDEV55	73.66[a]	13.9[c]	18.2[b]	28.6[bc]	24.8[c]
E8	56.00[b]	16.9[abc]	21.4[ab]	33.8[abc]	29.9[abc]
SE (±)	4.57	1.1	1.5	2.7	2.5
Establishment methods (E)					
Broadcasting	55.83[b]	18.0[a]	21.7	34.2	32.0
Drilling	65.60[a]	15.8[b]	20.5	30.8	28.3
SE (±)	2.89	0.7	1.0	1.7	1.5
Fertilizer Rates (kgha^{-1}) (F)					
0	56.05	13.8[c]	18.4[b]	27.1[b]	26.6[b]
100	64.85	20.3[a]	24.0[a]	35.7[a]	31.4[a]
150	61.25	16.6[b]	20.9[b]	34.8[a]	32.4[a]
SE (±)	3.54	0.8	1.2	2.1	1.9
Interaction(s)					
V x E	*	ns	ns	*	*
V x F	*	*	*	*	*
E x F	*	*	ns	ns	ns
V x E x F	*	*	ns	ns	ns
CV (%)	32.0	28.8	31.9	35.7	35.3

*Means followed by the same letter(s) within a sampling period are not significantly different at 0.05 level of probability using N-DMRT. C.V-Coefficient of variation. * - Significant at 5% level of probability*

Table 3: Heights of five sesame cultivars (*Sesamum indicum L.*) as influenced by varying fertilizer rates and establishment methods in Anyigba, during the 2023 cropping season

Treatments	Plant height (cm)				Leaf area (cm^2)			
	Weeks After Sowing							
	3	6	9	12	3	6	9	12
Varieties (V)								
NCRIBEN-01M	43.50[a]	55.22[ab]	83.47[a]	83.17[b]	45.7[a]	52.2[a]	44.8[ab]	35.2[ab]
NCRIBEN-02M	42.48[a]	56.10[ab]	80.48[a]	93.46[a]	52.8[a]	57.9[a]	37.4[b]	35.1[ab]
NCRIBEN-05E	32.41[b]	48.77[b]	70.30[b]	76.54[b]	42.5[a]	49.9[a]	41.1[ab]	40.5[a]
YANDEV55	36.35[ab]	47.90[b]	77.45[ab]	74.42[b]	30.5[b]	35.7[b]	53.8[a]	31.4[b]
E8	39.53[ab]	58.00[a]	82.70[a]	87.65[a]	42.9[a]	51.5[a]	53.6[a]	42.8[a]
SE (±)	2.96	3.16	3.48	3.59	4.2	4.8	4.6	3.16
Establishment methods (E)								
Broadcasting	37.42	52.96	80.16	84.45	46.1	53.9[a]	49.6	40.5[a]
Drilling	40.30	53.43	77.60	81.65	39.7	45.0[b]	42.7	33.6[b]
SE (±)	1.87	2.00	2.20	2.27	2.7	3.0	2.9	2.0
Fertilizer rates (kgha^{-1}) (F)								
0	33.59[b]	46.12[b]	68.76[b]	70.23[b]	33.5[b]	36.9[b]	41.8[b]	29.7[b]
100	42.41[a]	56.20[ab]	83.18[a]	86.77[a]	47.7[a]	55.1[a]	44.5[ab]	38.2[a]

150	40.58[ab]	57.27[a]	84.70[a]	92.16[a]	47.4[a]	56.3[a]	52.1[a]	43.2[a]
SE (±)	2.30	2.45	2.69	2.78	3.3	3.7	3.6	2.4
Interaction								
V x E	*	*	*	*	ns	ns	ns	ns
V x F	*	*	*	*	*	*	*	*
E x F	ns	ns	ns	*	*	ns	ns	ns
V x E x F	*	*	*	*	*	*	ns	ns
CV (%)	32.4	25.3	18.7	18.4	42.4	41.6	42.9	36.3

*Means followed by same letters within a sampling period are not statically different at 5% level of probability using N-DMRT. C.V-Coefficient of variation * - Significant at 0.05 level of test, ns – not significant at 0.05 level of test*

Table 4: Yield characters of sesame cultivars (*Sesamum indicum L.*) Under varying fertilization rates and establishment methods in Anyigba, during the 2023 cropping season

Treatments	**Yield characters**				
	Days to 50% flowering	**Number of Capsules/plants**	**Number of Seeds/capsule**	**Number of Seeds/plant**	**Seed Yield (g/plot)**
Varieties (V)					
NCRIBEN-01M	54.16[a]	20.61[ab]	57.16	1294.72[ab]	1063.7[a]
NCRIBEN-02M	52.72[b]	17.77[b]	57.50	1123.89[ab]	1028.4[a]
NCRIBEN-05E	53.55[ab]	16.66[b]	48.38	896.11[b]	1065.5[a]
YANDEV55	53.00[b]	20.27[ab]	53.50	1161.83[ab]	919.0[b]
E8	51.05[c]	23.33[a]	58.22	1428.94[a]	995.9[ab]
SE (±)	0.37	1.55	3.64	158.57	33.8
Establishment methods (E)					
Broadcasting	52.86	20.66	53.31	1188.04	974.0[b]
Drilling	52.93	18.80	56.60	1174.16	1055.0[a]
SE (±)	0.23	0.98	2.30	100.29	21.4
Fertilizer rates (kgha^{-1}) (F)					
0	53.30[a]	15.70[b]	48.66[b]	854.80[b]	1044.9
100	53.60[a]	21.10[a]	53.73[ab]	1185.77[ab]	1011.9
150	51.80[b]	22.40[a]	62.46[a]	1502.73[a]	986.7
SE (±)	0.28	1.20	2.82	112.82	26.2
Interaction(s)					
V x E	*	*	ns	*	*
V x F	*	*	*	*	*
E x F	*	*	ns	ns	*
V x E x F	**	*	*	*	ns
CV (%)	3.0	33.5	28.1	57.0	14.2

*Means followed by same letters within a sampling period are not statically different at 5% level of probability using N-DMRT. C.V-Coefficient of variation * - Significant at 5% level of test, ns – not significant*

Table 5: Biological yield and Economic yield of Sesame cultivars (*Sesamum indicum L.*) under varying fertilizer rates and establishment methods in Anyigba, during the 2023 cropping season

Treatments	**Total plant biomass yield (g/plot)**	**Haulm yield (g/plot)**	**Harvest index (%)**	**Final seed yield (kgha^{-1})**
Varieties (V)				
NCRIBEN-01M	2899.9[a]	32.8[ab]	36.6	886.4[a]
NCRIBEN-02M	2862.2[a]	33.0[a]	35.9	856.9[a]
NCRIBEN-05E	2908.0[a]	32.9[ab]	36.6	887.9[a]
YANDEV55	2471.4[b]	30.9[b]	37.5	765.8[b]

E8	2800.4^{a}	32.6^{ab}	34.7	829.9^{ab}
SE (±)	51.4	0.7	1.6	28.2
Establishment methods (E)				
Broadcasting	2682.1^{b}	32.0	36.1	811.6^{b}
Drilling	2894.6^{a}	32.9	36.4	879.2^{a}
SE (±)	32.5	0.4	1.0	17.8
Fertilizer rates (kgha^{-1}) (F)				
0	2724.9^{b}	31.4^{b}	35.6	822.2^{c}
100	2760.6^{b}	33.0^{a}	36.2	843.2^{ab}
150	2879.7^{a}	33.0^{a}	36.9	870.7^{a}
SE (±)	39.8	0.59	1.30	10.3
Interaction(s)				
V x E	**	ns	ns	*
V x F	*	ns	ns	*
E x F	*	ns	ns	*
V x E x F	ns	ns	ns	ns
CV (%)	7.8	10.0	19.6	14.2

*Means followed by same letters within a sampling period are not statically different at 5% level of probability using N-DMRT. C.V-Coefficient of variation * - Significant at 5% level of test, ns – not significant*

Interaction(s) of Variety x Establishment Methods (V x E), Variety x Fertilizer (V x F) on Some Growth Characters of Sesame in Anyigba

Table 6 presents the Interaction of V x E on plant height at 12 weeks of sampling. NCRIBEN-02M x drilling was the best interaction. Seeds established by drilling were 20.7% taller than those established by broadcast, this was followed by NCRIBEN-01M x broadcast interaction where the variety (NCRIBEN-01M) responded better to broadcasting (94.8 cm) than drilling (71.4 cm).

Similarly, interaction of V x E on number of leaves at 12 WAS (table 7) indicated that only NCRIBEN-05E x broadcasting had the best interaction. NCRIBEN-05E established by broadcast method produced 22.9 % more leaves when compared to drilling method during these sampling stages. At 12 WAS (table 8), YANDEV55 x 150 kg NPK/ha was the best interaction, followed by NCRI-05E x 150 kg NPK/ha. E8 variety though produced the tallest plant when fertilized with 150 kg of NPK/ha but did not differ significantly from heights obtained when treated with 100kg of NPK/ha fertilizer. Interaction of V x F on number of leaves at 12 WAS (table 9) indicated that NCRIBEN-02M x 100 kg NPK/ha was the best interaction.

The variety's response to 100 kg NPK/ha produced the highest number of leaves (49.0) followed by E8 x 150 kg NPK/ha which produced 39.4 leaves. Interaction E8 x 150 kg NPK/ha appears to be optimum for leaf area at 12WAS (table 10). E8 produced the widest leaf are 62.6 cm^2 during this sampling period. This value was 34.2 % greater than its corresponding value from plots treated with 100 kg NPK/ha respectively.

Table 6: Interaction of Varieties x Establishment method on plant height at 12 weeks of sampling

Establishment method	Varieties					SE (±)
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8	
Broadcasting	94.8^{ab}	82.6b^{-e}	83.4b^{-e}	74.9^{cde}	86.4b^{cd}	5.0
Drilling	71.5^{e}	104.2a	69.6^{e}	73.9d^{e}	88.9^{bc}	

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 7: Interaction of Varieties x Establishment method on number of leaves at 12 weeks of sampling

Establishment method	Varieties				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
Broadcasting	37.8^{ab}	39.1^{a}	30.1^{cd}	25.0^{de}	28.2^{cde}
Drilling	28.5^{cde}	33.4^{abc}	23.2^{e}	24.7^{de}	31.7^{bc}
SE (±)	2.2				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 8: Interaction of Varieties x Fertilizer on plant height at 12 weeks of sampling

NPK rates (kg/ha)	Varieties				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
0	83.3cd	87.3bc	61.9f	65.3ef	53.1f
100	83.9cd	104.4ab	81.7cde	66.6def	97.0abc
150	82.2cde	88.6bc	85.9c	91.2bc	112.7a
SE (±)	6.2				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 9: Interaction of Varieties x Fertilizer on number of leaves at 12 Weeks of sampling

NPK rates (kg/ha)	Varieties				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
0	41.1ab	25.3def	26.1def	21.0ef	19.6f
100	29.4b-f	49.0a	26.6def	21.3ef	30.8b-f
150	28.8c-f	34.4bcd	27.3cde	32.2b-e	39.4abc
SE (±)	4.3				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 10: Interaction of Varieties and Fertilizer on Leaf area of sesame crop at 12 weeks of sampling

NPK rates (kg/ha)	Varieties				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
0	40.2b-e	30.9c-g	30.1c-g	22.6fg	24.8efg
100	43.5bc	36.7b-g	41.5bcd	28.0d-g	41.2bcd
150	22.0g	37.8b-f	49.8ab	43.7bc	62.6a
SE (±)	5.4				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Interaction(s) of Variety x Establishment Method (V x E), Variety x Fertilizer (V x F) and Establishment Method x Fertilizer (E x F) on Some Yield and Yield Characters of Sesame in Anyigba

Interaction of V x E on days to 50% anthesis and final seed yield/ha (table 11a) shows YANDEV55 x drilling is the best interaction followed by E8 x drilling on days to 50% anthesis. The variety (YANDEV55) established by drilling method took 54.00 days to 50% anthesis. This differ significantly from NCRIBEN-02M x broadcast interaction where NCRIBEN-02M took 53.44 days to 50% anthesis. Interaction of E8 x drilling appeared to be the best interaction on final seed yield. this was however followed by YANDEV55 x drilling interaction. E8 produced the highest grain yield of 894.3 kg/ha when established using drilling method and this was 14.4% higher than seed yield obtained when plots were established using broadcast method. Similarly, in table 11b, NCRIBEN-01M x broadcasting appears to be the best interaction on number of capsules/plant and seeds/plant. NCRIBEN-01M produced 24.55 capsules and 1621.4 seeds when grown by broadcast method and this was 32.1 and 40.3 % higher than the number of capsules and seeds obtained per plant under drilling.

Interaction of V x F on number of seeds/capsule and number of capsules/plant are presented in table 12a. Interaction of NCRIBEN-05E x 150 kg NPK/ha appears to be the best interaction as the variety produced plants with higher number of seed/capsule (67.33) from plots treated with 150 kg/ha of NPK fertilizer and this differ significantly by 46.3% from the number of seed/capsules obtained with 100 kg NPK/ha which happen to be the lowest. Alternatively, NCRIBEN-02M x 100 kg NPK/ha appears to be the best interaction for number of capsule/plant. This variety produced plants with 24.6 capsules/plant from plots fertilized with 100 kg NPK/ha and this differ from the plots treated with 150 kg NPK/ha by 34.4%.

Interaction of E x F on seed yield/plot and total plant biomass yield as presented in table 13 indicated that drilling x 100 kg NPK/ha fertilizer was the best interaction for seed yield/plot and total plant biomass yield. Plots established using drilling methods produced seed yield of 1082.9 g/plot and biomass yield of 2906.4 g/plot when treated with 100 kg NPK/ha fertilizer. These interactions were followed by drilling x 150 kg NPK/ha as obtained for both characters.

Table 11: Interaction of Varieties x Establishment method

Establishment Method	50% Anthesis					Final seed yield (kgha^{-1})				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
Broadcasting	54.00^{a}	53.44^{b}	54.11^{a}	52.00^{c}	50.77^{e}	879.4^{a}	862.5^{ab}	892.6^{a}	658.0^{c}	765.5^{bc}
Drilling	54.33^{a}	52.00^{c}	53.00^{a}	54.00^{a}	51.33d	893.4^{a}	851.4^{ab}	883.2^{a}	873.5^{ab}	894.3^{a}
SE (±)	**0.52**					**39.9**				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 12: Interaction of Varieties x Establishment method

Establishment Method	Number of capsules/plant					Number of seeds/plant				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
Broadcasting	24.55^{a}	18.66^{abc}	15.88^{c}	20.22^{abc}	24.00^{a}	1621.4^{a}	1179.3^{abc}	757.6^{c}	1018.0^{abc}	1363.7^{abc}
Drilling	16.66^{bc}	16.88^{bc}	17.44^{bc}	20.33^{abc}	22.66^{ab}	968.0^{b}	1068.4^{abc}	1034.5^{abc}	1305.6^{abc}	1494.1^{ab}
SE (±)	**2.20**					**224.2**				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 13: Interaction of Varieties x Fertilizer

NPK rates (kg/ha)	Number of Seeds/capsule.					Number of capsule/plant				
	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8	NCRIBEN-01M	NCRIBEN-02M	NCRIBEN-05E	YANDEV55	E8
0	52.83^{a-f}	46.83^{b-f}	41.66^{ef}	58.16^{a-e}	43.83^{def}	17.16^{b-f}	12.50^{f}	12.50^{f}	21.16^{a-e}	15.16^{ef}
100	64.16^{ab}	64.00^{ab}	36.16^{f}	44.16^{c-f}	60.16^{a-d}	21.16^{a-e}	24.66^{ab}	17.00^{c-f}	14.83^{ef}	27.83^{a}
150	54.50^{a-e}	61.66^{abc}	67.33^{a}	58.16^{a-e}	70.66^{a}	23.50^{a-d}	16.16d^{ef}	20.50^{a-e}	24.83^{a}	27.00^{a}
SE (±)	**6.31**					**2.69**				

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

Table 14: Interaction of Establishment method x Fertilizer

Establishment method	Seed yield (g/plot)			Total plant biomass yield (g/plot)		
	NPK Rates (kgha^{-1})					
	0	100	150	0	100	150
Broadcasting	1050.6^{a}	940.9^{bc}	930.3^{c}	2873.0^{a}	2543.3^{bc}	2630.0^{b}
Drilling	1039.1^{ab}	1082.9^{a}	1043.0^{ab}	2886.3^{a}	2906.4^{a}	2891.1a
SE (±)	**37.0**			**56.3**		

Means followed by the same letter(s) within a sampling period are not statically different at 5% level of probability using N-DMRT

DISCUSSION

Effect of Variety on Growth, Yield Characters and Yield of Sesame

Significant effect of varieties on growth characters such as establishment count, leaf area, number of leaves and plant height has been reported by Caliskan, *et al.*, (2004); El-Naim (2010); Ismaan *et al.*, (2020). Differential varietal behavior observed during the period of the study can be traced to differences in their genetic make-up. Similarly, outstanding performance of variety NCRIBEN-02M in Leaf area and number of leaves may have explained that the variety possessed the optimum ability to harvest maximum solar radiation and therefore accumulate and translocate more photosynthates which drives yield (Eifediyi *et al.*, 2018; Musa *et al.*, 2020). Umar (2011); Muhammed and Hamidu, (2018) has reported that increased number of leaves leads to increase in capsule formation. The significant difference between varieties in all the growth stages especially in aspect leaf production may be attributed to the fast growth of sesame plants between emergence to 12 WAS (Anonymous, 2009). Similarly, other authors have reported that vegetative growth leading to establishments of higher branches, taller plants and increased number of leaves could be attributed to soil, environmental condition and probably genetic make-up of varieties involved (Anon 2004; Magashi and Yusuf 2013; Mulkey *et al.* 2017). Survey reports by various researchers from different agro-ecological zones of Nigeria revealed that the yield of the sesame crop is low as the crop growth may be poor, probably due to lack of improved varieties. This explained the performances of YANDEV55 and E8 in establishment count and plant height. This is also in line with results of (Madina, 2020). Most yield characters were also influenced by varieties and thus has reflected in works of Baker and Briggs, (2007), Nandita *et al.*, (2009) and Bennet, (2011). El-Naim, (2010) demonstrated varietal differences in number of branches/plant, Tahir *et al.*, (2012) also reported variation in capsules/plant as influenced by varieties. Higher performance of NCRIBEN-01M variety on days to anthesis, capsule/plant and number of seed/plant may be a clear indication that this variety is widely adapted to the soil and climatic condition of Anyigba environment. This is in line with Madina (2020) who also reported higher number of capsule with E8 variety followed by NCRIBEN-01M. Muhammed and Hamidu, (2018), reported that adaptability of new variety to certain soil and climatic conditions is directly proportional to growth attributes which are partitioned to the capsule yield. Ismaan *et al.* (2020) also confirmed that a wide variety of environments probably affects growth and yield performance.

Geleta *et al.* (2002) highlighted some environmental factors and management practices that may affect productivity of sesame varieties, some of which may partially mitigate others. Similarly, Islam *et al.* (2008), insinuated that lower yield of sesame crop is partly due to the low yielding cultivars and partly due to the lack of appropriate agronomic practices. This may have explained the lower performances of varieties YANDEV55 on leaf area, number of leaves, seed yield/plot, total plant biomass yield, haulm yield and final seed yield/ha. Significant effect of variety on final grain yield may have resulted from the inherent varietal attributes and their ability to adapt to Anyigba environment our result is in line with the reports of Langham *et al.* (2008) and Bruno (2014) who highlighted the potential yield (kg/ha) of these varieties tested in this research.

Effect of Establishment Methods on Sesame Growth and Yield

Significant effect of establishment methods of sesame crop on growth characters in Anyigba has been reported by many authors. In our findings, growth characters performed optimally under broadcasting method of establishment due probably to the fact that broadcasting restrict excessive competition for available resource due to its disperse placement and thus allows for optimum growth performance (Imoloame *et al.*, 2007). Seed drilling method had 9.77% higher germination than broadcasting method this may have resulted from seed loss at the time of planting (i.e. spillage, by means of wind dispersion) with broadcasting method which reduced germination as compared to drilling where seeds are properly planted and covered with light soil. Similarly, clumsiness associated with broadcast method may have increased competition for growth resource such as light, water, space which results in optimum growth. Our results coincide with Islam *et al.* (2008) who obtained higher number of branches and main stem capsules/plant from broadcasting method of planting.

Adnan *et al.* (2015) also obtained higher number of leaves and capsules from broadcasting method of planting. Olowe *et al.* (1998) also reported taller plants and higher dry matter from broadcast method of sowing when compared with drilling and dibbling methods. Drilling method favors yield and yield characters of sesame in Anyigba environment than broadcasting method. This result is in line with the findings of Caliskan *et al.* (2004); Imoloame *et al.*, (2007); Lipi and Maniruzzaman (2023), where row planting method was reported to have higher yield and yield components than the broadcasting method. Optimum seed yield/plot, Total Plant Biomass and Yield, seed yield/ha obtained with seed drilling method of crop establishment agrees with the work of Lipi and Maniruzzaman (2023) who found row planting and increasing seed rate to be significantly increasing seed yield and 1000-seed weight. This has been attributed to the fact that row planting method with less planting density may have sufficient light, moisture, nutrients, and perhaps favorable environmental conditions which favored plant growth thus translating to higher yield (Kalaiyarasi, 2019). Caliskan *et al.*, (2004) obtained 34% yield increase from row planting against broadcasting method.

Yield response of sesame to drilling method in Anyigba could have also resulted from the fact that it allows for spatial distribution of plants, thus providing sufficient space for light interception, moisture and nutrient as against broadcasting where plants may be chocked and hinder even these factors.

Phenotypically, growths of sesame plants were highly variable under broadcast method of planting. Same has been reported in several crop species by Wade (1990) in sunflower.

Effect of Fertilizer on Growth and Yield of Sesame

Significant effect of fertilizer on growth characters of sesame in Anyigba environment coincides with the reports of Ndor and Nasiru (2019); Zenawi and Mizan (2019); Usman *et al.* (2021) respectively. These positive responses may be explained by the state of the soil (i.e. degraded soil). As NPK fertilizer was applied, there was a spontaneous response by sesame crop. This is also in line with the reports of (Ndor and Nasiru 2019) who ascribed fertilizer response of sesame crop to degraded soil and lower soil nutrients. In this experiment, application of 100kg/ha of fertilizer proved optimum to almost all growth characters as further increase declined growth. This is also in tandem with Haruna (2011); HUARC (2012) and Motaka *et al.* (2016) who reported delayed flowering with higher N, taller plants, higher LAI, increased branches and total dry matter with higher N between 75 and 100 kg/ha. Similarly, increased yield characters and yield obtained in this experiment has been reported by Babajide and Oyeleke (2014), who obtained significant increase in the yield and yield attributes of sesame with increased Nitrogen fertilizer up to 100 kg/ha. It is worthy of note that nutrient status of most Nigerian soils with history of intensive cultivation are generally low, therefore sesame crop tends to respond faster to dynamics of fertilizer and this translate to yield attributes.

From our results, yield performance at 150 and 100kg/ha of fertilizer were statistically the same, this implies that 100kg/ha of fertilizer is optimum for yield and yield attribute of sesame in Anyigba. This also agrees with the works of (Shehu *et al.*, 2009); (Shehu, 2014) who reported higher seed yield with 75 kg N/ha fertilization (i.e. 56.09 % increase over control plots), (Haruna, 2011) obtained higher number of capsules/plant and seed yield from 50kg N/ha fertilization. Zenawi and Mizan (2019) stated that application of 46 – 100 kg N per ha could be economical and fruitful while 50 – 100 kg N/ha will give a significant oil content when compared with zero fertilization (Babajide & Oyeleke 2014; Motaka *et al.*, 2016). Eifediyi *et al.* (2016) also revealed highest grain yield from the application of 400 kg ha^{-1} and 300kg ha^{-1} in their experiment in 2013 and 2014 respectively.

Interaction of Variety x Establishment Method (V x E), Variety x Fertilizer (V x F) and Fertilizer x Establishment Method (F x E) on Growth and Yield of Sesame

Significant response of varieties to drilling method of plant establishment obtained in this research correlate with the findings of Mahmoud *et al.* (2020). Improved seed yield and other yield characters such as days to flowering, capsule/plant, total plant biomass and haulm yield under drilling has been attributed to improved nutrient availability and efficient utilization by improved crop varieties throughout the growing season which improves growth and photosynthetic activities (Weiss, 2000; Katanga *et al.*, 2017). This is evident with varieties E8 and YANDEV55 in this research. El-Shamy *et al.* (2017) found that seed drilling planting of sesame and wheat, on beds increased grain yield than other planting methods. Other advantages of drilling that favors sesame growth and yield as highlighted by Mahmoud *et al.* (2020) include higher deposition of more fertile topsoil on beds as opposed to furrows concentrated with weeds resulting from insufficient cover crop, higher moisture content under raised soil bed and reduced soil surface exposed to flooding. However, growth parameters responded better to broadcasting than drilling. This is in line with the works of Islam *et al.* (2008); Adnan *et al.* (2015).

Significant response of sesame varieties to fertilizer rates on growth and yield characters as obtained in this experiment results from the use of improved varieties. As reported by Babbu *et al.*, (2015), use of inorganic fertilizers often result in higher soil organic matter content and biological activities resulting from increased plant biomass i.e. roots, litters and crop residues which further undergoes decay. Outstanding performance of NCRIBEN-02M, YANDEV55 and E8 on Leaf production, Leaf area, plant height and % emergence at 100kg/ha fertilization prove this assertion as they efficiently put these components to use. Other authors have reported that improved varieties perform better under the application of inorganic fertilizer than local varieties (Ojeniyi *et al.*, 2016; Eifediyi *et al.*, 2018).

CONCLUSION

From the foregoing result of this study, it is pertinent to note that, sesame crop varied in forms, growth and yield, fertilizer application in the form of NPK 15-15-15 significantly influenced growth, development and seed yield of the crop, Application of 100 kg NPK/ha appears maximum for optimum yield of the crop. Drilling as a method of establishment on the other hand has significant influence on leaf expansion (leaf area) and seed yield only, producing a marginal increase of 8.4 % over broadcast. significantly high fertilizer x cultivar interaction obtained during the period of the trial is an indication that the varieties do not behave alike under varying fertilization. The best variety with respect to yield/ha is NCRIBEN-02M. This variety however did not differ from NCRIBEN-01M and YANDEV55 respectively. significant interaction of varieties x establishment method obtained was also an indication that very high yielding varieties (NCRIBEN-02M and NCRIBEN-01M) do better when drilled compared to broadcast. The significant positive association of some yield character x yield and growth x yield is an indication that effective crop improvement through selection can be carried out by selecting for those characters that correlated positively with yield.

Acknowledgement

We are grateful to Prince Abubakar Audu University for providing us the experimental field and other technical support.

REFERENCES

Adnan, A. A., Yahaya, B. D., & Abdulwahab, S. S. (2015). Growth, yield, and phenology of sesame (*Sesamum indicum L.*) as affected by sowing method, variety, and seed rate in the Sudan savanna of Nigeria. *Journal of Dryland Agriculture, 1*(1), 1–9.

Ahmed, H. G., Aliyu, U., Haruna, A. B., Isa, Y. S., & Muhammad, A. S. (2009). Effects of planting date and weeding regimes on growth and yield of sesame (*Sesamum indicum L.*) in Sokoto, north-western Nigeria. *Nigerian Journal of Basic and Applied Sciences, 17*(2), 202–206.

Amhakhian, S. O., Isitekhate, H. H., & Ezeaku, P. I. (2012). Influence of land uses on structural stability of some Guinea savanna soils in Anyigba, Kogi State. *Proceedings of the Soil Science Society of Nigeria, 30,* 308–314.

Anon (2004). *Research report on hybrid sunflower, sesame and spelt crop insurance programs.* Watts and Associates, Billings, M.T. P. 1 – 96.

Anonymous (2009) Sesame seed produce in Nigeria http://www.NigeriaEmbassy.cn/eco/PRODUCE%200F%20Nigeria.htm 2010.

Babajide, P. A., & Oyeleke, O. A. (2014). Evaluation of sesame (*Sesamum indicum*) for optimum nitrogen requirement under usual farmers' practice of basal organic manuring in the Savanna ecoregion of Nigeria. *Journal of Natural Sciences Research, 4*(17), 2224–3186.

Babbu, S. B., Jagdeep, S., Gurbir, S., & Gurpreet, K. (2015). Effects of long-term application of inorganic and organic fertilizers on soil organic carbon and physical properties in maize–wheat rotation. *Agronomy Journal, 5,* 220–238.

Baker, R. J., & Briggs, K. G. (2007). Effects of Plant Density on the Performance of 10 Barley Cultivars. Crop Development Ctr., Univ. of Saskatchewan, Saskatoon, Sask. S7N 0W0, and professor, Dep. of Plant Science, Univ. of Alberta, Edmonton, Alta. T6G 2H1, respectively.

Bedigian, D. (2003a). Evolution of sesame revisited: Domestication, diversity, and prospects. *Genetic Resources and Crop Evolution, 50,* 779–787.

Bedigian, D. (2003b). Sesame in Africa: Origin and dispersals. In K. Neumann, A. Butler, & S. Kahlheber (Eds.), *Food, fuel and fields: Progress in African archaeobotany* (pp. 17–36). Africa Praehistorica. Heinrich-Barth-Institute.

Bennet, M. (2011). *Sesame seed: A handbook for farmers and investors.* Available at: www.agmrc.org/media/cm/sesame_38f4324ee52cb.pdf

Biswas, T. K., Sana, N. K., Badal, R. K., & Haque, E. M. (2001). Biochemical study of some oil seeds (Brassica, sesame, & linseed). *Pakistan Journal of Biological Sciences, 4,* 1002–1005.

Black, C. A. (1965). *Methods of analysis II: Chemical and microbiological properties.* American Society of Agronomy.

Bray, R. H., & Kurtz, L. K. (1945). Determination of total, organic, and available forms of phosphorus in soil. *Soil Science, 59,* 39–45. https://doi.org/10.1097/00010694-194501000-00006

Bremer, J. N., & Mulvaney, C. S. (1982). Total nitrogen. In Page *et al.* (Eds.), *Methods of soil analysis* (pp. 953–624). American Society of Agronomy.

Bruno, D. (2014). *Farmer's guide for the production and post-harvest handling of sesame products in Nigeria.* In Expanding export of sesame seed and sheanut/butter through improved SPS capacity building for public and private sectors: A training manual (pp. 1–48). STDF Project 172.

Caliskan, S., Arslan, M., Arioglu, H., & Isler, N. (2004). Effect of planting method and plant population on growth and yield of sesame (*Sesamum indicum L.*) in a Mediterranean type of environment. *Asian Journal of Plant Sciences, 3*(5), 610–613.

Day, P. R. (1965). Particle fractionation and particle size analysis. In C. A. Black (Ed.), *Methods of soil analysis: Part 1* (pp. 545–567). American Society of Agronomy.

Dudley, T. S., Grichan, W. S., & McGallum, A. A. (2000). Crop profile for sesame in the United States. https://www/emcenters.org/cropprofile/docs/ussesame.html

Duncan, D. B. (1955). Multiple range and multiple F-test. *Biometrics, 11,* 1–42.

Eifediyi, E. K., Ahamefule, H. E., Ojiekpon, I. F., Agbede, T. M., Remison, S. U., Aliyu, T. H., Olukayode, T. O., & Bangura, A. K. (2016). Response of sesame (*Sesamum indicum L.*) to mulching and inorganic fertilizer application in a Southern Guinea Savanna Zone of Nigeria. *Agriculture & Forestry, 6*(2), 201–216.

Eifediyi, E. K., Komolafe, O. A., Ahamefule, H. E., & Folola, A. (2018). Effect of tillage and poultry manure rates on physiological growth and yield of sesame (*Sesamum indicum L.*). *Scientia Agriculturae Bohemica, 49*(4), 255–266.

El-Naim, A. (2010). Effect of plant density on the performance of some sesame (*Sesamum indicum L.*) cultivars under rain-fed research. *Journal of Agriculture and Biological Sciences, 8*(3), 28–42.

El-Shamy, M. A., Seleiman, M. F., El-Gaafary, T. G., & Rady, H. Y. A. (2017). Effect of different sowing methods on growth, yield, and its components of wheat under intercropping patterns with Egyptian clover Var. Fahl. *Assiut Journal of Agricultural Sciences, 48*(3), 67–80.

Exchange (African Investment Gateway). (2024). NIGERIA: Sesame seeds market size to hit $17.77 globally. *Africa's Newsletter.* https://theexchange.africa/countries/nigeria-sesame-seeds-market-size-to-hit-17-77-globally/

FAOSTAT. (2001). Overview of the Nigerian sesame industry. United States Agency for International Development (USAID).

FAOSTAT. (2013). FAOSTAT database results. http://www.faostat.org

FAOSTAT. (2018). FAOSTAT database results. http://www.faostat.org

Gebregergis, Z., & Amare, M. (2019). Effect of nitrogen fertilization on the growth and seed yield of sesame (*Sesamum indicum L.*): A review. *International Journal of Agronomy,* 1–9.

Geleta, B., Atak, M., Baenziger, P. S., Nelson, L. A., Baltenesperger, D. D., Eskridge, K. M., ... & Shelton, D. R. (2002). Seeding rate and genotype effects on agronomic performance and end-use quality of winter wheat. *Crop Science, 42*(3), 827–832.

Gharby, S., Harhar, H., Bouzobaa, Z., Asdadi, A., El-Yadini, A., & Charrouf, Z. (2017). Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. *Journal of the Saudi Society of Agricultural Sciences, 16,* 105–111.

Haruna, I. (2011). Growth and yield of sesame (*Sesamum indicum L.*) as influenced by nitrogen and intra-row spacing in Lafia, Nasarawa State of Nigeria. *Elixir Agriculture, 41,* 5685–5688.

HUARC. (2012). Determination of optimum urea and DAP fertilizer requirements of sesame. In *Enhancing the productivity of sesame through introduction and development of new technologies* (pp. 1–20). Tigray Agricultural Research Institute, Mekelle, Ethiopia.

International Institute of Tropical Agriculture. (1975). *Annual report 1973-1974.* International Institute of Tropical Agriculture.

Imoloame, E. O., Gworgwor N. A., Joshua S. D., (2007), Sesame (*Sesamum indicum L.*) weed infestation yield and yield components as influenced by sowing method and seed rate in Sudan savannah agro-ecology of Nigeria. *African Journal of Agricultural Research 2*(10), 525 – 533.

Islam, M. S., Akhter, M. S. I., Sikdar, M. M., Rahman, M. M., & Azad, A. K. (2008). Effect of planting density and methods of sowing on yield and yield attributes of sesame. *International Journal of Sustainable Agriculture Technology, 4*(2), 83–88.

Islam, F., Gill, R. A., Ali, B., Farooq, M. A., Xu, L., Najeeb, U., & Zhou, W. (2016). Sesame. In S. K. Gupta (Ed.), *Breeding oilseed crops for sustainable production: Opportunities and constraints* (pp. 135–147). Academic Press.

Ismaan, H. N., Siad, S. A., Isse, M. M., Islam, M. S., & Sidkar, S. I. (2020). Evaluation of new sesame varieties for growth and yield performance in the summer season in Afgoi, Somalia. *Journal of Agriculture and Veterinary Science, 13*(5), 58–61. https://www.iosrjournals.org

Iwo, G. A., Idowo, A. A., & Ochigbo, A. A. (2002). Evaluation of sesame genotypes for yield stability and selection in Nigeria. *Nigerian Agricultural Journal, 33,* 76–82.

Kalaiyarasi, R., Rajasekar, R., Lokeshkumar, K., Priyadharshini, A., & Mohanraj, M. (2019). Correlation and path analysis for yield and yield traits in sesame (*Sesamum indicum L.*) genotypes. *International Journal of Current Microbiology and Applied Sciences, 8*(11), 1251–1257.

Katanga, Y. N., Danmaigoro, O., & Buba, Y. (2017). Effect of sowing methods, seed rate, and variety on yield and seed quality of sesame (*Sesamum indicum L.*) and its implication on returns in the Sudan Savanna of Nigeria. *Asian Research Journal of Agriculture, 6*(4), 1–7.

Langham, D. R., Riney, J., Smith, G., & Terry, W. (2008). *Sesame growers guide.* SESACO: Sesame Coordinators. https://www.sesaco.net

Lipi, N. J., & Maniruzzaman, M. (2023). Effect of planting methods and planting density on growth and yield of sesame in non-saline areas of Patuakhali, Bangladesh. *Journal of Agroforestry and Environment, 16*(2), 14–18. https://doi.org/10.55706/jae

Madina, P. (2020). Performance of ten (10) varieties of sesame (*Sesamum indicum*) grown in Billiri, Gombe State, Nigeria. *FUDMA Journal of Sciences, 4*(3), 453–456. https://doi.org/10.33003/fjs-2020-0403-412

Magashi, D., & Yusuf, H. I. (2013). Planting date effect on plant growth and development in sesame. *Agronomy Journal, 79,* 701–703.

Mahmoud, A. M., Ali, E. A., Said, M. T., Abdelazeem, A. H., & Salem, A. M. (2020). Impact of planting methods on some sesame cultivars production. *Assiut Journal of Agricultural Sciences, 51*(3), 49–61. https://www.aun.edu.eg/faculty_agriculture/journals_issues_form.php

Mohammed, B., & Hamidu, G. A. (2018). Growth and yield performance of sesame (*Sesamum indicum L.*) varieties at varying levels of inter-row spacing in the northern part of Sokoto, Nigeria. *Asian Journal of Research in Crop Science, 1*(2), 1–14. https://doi.org/10.9734/AJRCS/2018/40304

Motaka, G., Paramar, D., & Patel, J. (2016). Response of sesame (*Sesamum indicum L.*) to organic and inorganic sources of nitrogen in light-textured soils of the semi-arid Bhal region. *Bioscan, 11*(3), 1653–1658.

Mulkey, J. R., Drawe, H. I. (Jr.), & Elledge, R. E. (2017). Planting date effect on plant growth and development in sesame. *Agronomy Journal, 79,* 701–703.

Musa, U. T., Yusuf, M., & Ojo, S. O. (2020). Leaf area determination for sesame (*Sesamum indicum*), wheat (Triticum aestivum), groundnut (Arachis hypogaea), and bambaranut (Vigna subterranea) crops using linear measurements. *Journal of Biology, Agriculture and Healthcare, 10*(12), 20–26.

Nandita, R. S., Abdullah, M., Mamun, H. A., & Jahan, S. (2009). Yield performance of sesame (*Sesamum indicum L.*) varieties at varying levels of row spacing. *Agro-technology Discipline, Khulna University, Khulna, Bangladesh.*

Nigerian Cereals Research Institute (NCRI). (2002). *Guide to beniseed (sesame) production.* Oilseed Research Program. NCRI.

Ndor, E., & Nasir, I. U. (2019). Response of sesame (*Sesamum indicum L.*) to sowing methods and fertilizer types on degraded soil of Southern Guinea Savanna agro-ecological zone, Nigeria. *East African Scholars*

Journal of Agriculture and Life Sciences, 2(6), 312–316.

Ojeniyi, S. O., Ibrahim, N. B., & Iorlamen, T. (2016). The effects of different types of fertilizers on the growth and yield of sesame (*Sesamum indicum L.*) in Makurdi. *Nigerian Journal of Soil Science, 26,* 272–278.

Okpara, D. A., Maoneke, C. O., & Ojikpong, T. O. (2007). Effect of nitrogen and phosphorus fertilizer rates on the growth and yield of sesame (*Sesamum indicum L.*) in the southeastern rainforest belt of Nigeria. *Nigeria Agricultural Journal, 38,* 1–8.

Olowe, V. I. C., Busari, I. D., Yusif, I. A., & Idowu, A. A. (1998). Research on sesame agronomy in Nigeria. In *Proceedings of the first national workshop on benniseed* (pp. 75–85). NCRI, Baddegi.

Purseglove, J. W. (1974). *Tropical crops, dicotyledons.* Longman. pp. 430–435.

Shehu, H. E. (2014). Uptake and agronomic efficiencies of nitrogen, phosphorus, and potassium in sesame (*Sesamum indicum L.*). *American Journal of Plant Nutrition and Fertilizer Technology, 4*(2), 41–56. https://doi.org/10.3923/ajpnft.2014.41.56

Shehu, H., Kwari, J., & Sandabe, D. M. (2009). Nitrogen, phosphorus, and potassium nutrition of sesame (*Sesamum indicum L.*) in Mubi, Nigeria. *Research Journal of Agronomy, 3*(3), 32–36.

Tahir, M., Saeed, U., Ali, A., Hassan, I., Naeem, M., Ibrahim, M., Rehman, H., Javeed, M. R. (2012). Optimizing sowing date and row spacing for newly evolved sesame (*Sesamum indicum L.*) variety TH-6. *Pak. J. Life Soc. Sci., 10*, 1 – 4.

Tridge. (2020). *Sesame: Industry report.* pp. 1–20.

Umar, U. A. (2011). Effects of herbicides and manual weed control on growth and yield of sesame (*Sesamum indicum L.*) as influenced by nitrogen fertilizer level and intra-row spacing (Master's thesis, Faculty of Agriculture, Ahmadu Bello University, Zaria, Kaduna State).

USAID. (2002). *Overview of the Nigerian sesame industry.* Washington DC: Chemonics International Inc. pp. 20–50.

Usman, M., Ali, A., & Olatunji, O. (2021). Influence of sesame varieties and fertilizer levels on the yield of sesame in Potiskum, Yobe State, Nigeria. *Nigerian Journal of Soil Science, 31*(1), 36–43. https://doi.org/10.36265/njss.2020.310105

Uzun, B., Yol, E., Furat, S., Topakci, M., Canakci, M., & Karayel, D. (2012). The effects of different tillage methods on the post-wheat second crop sesame: Seed yield, energy budget, and economic return. *Turkish Journal of Agriculture, 36,* 399–407.

Wade, L. J. (1990). Estimating loss in grain yield due to suboptimal plant density and non-uniformity in plant spacing. *Australian Journal of Experimental Agriculture, 30,* 251–255.

Weiss, E. A. (2000). *Oil seed crops* (2nd ed.). Oxford: Blackwell Science.

Zenawi, G., & Mizan, A. (2019). Effect of nitrogen fertilization on growth and seed yield of sesame (*Sesamum indicum L.*). *International Journal of Agronomy,* 1–7. https://doi.org/10.1155/2019/5027254