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Effects of Rate of Nitrogen Fertilizer and Intra -row spacing on Growth and Yield of Sesame (*Sesamum indicum* L.) in the Sudan Savanna Zone of Nigeria

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Abstract: *Field trials were conducted to evaluate the effects of nitrogen rates and intra-row spacings on growth and yield of sesame (Sesamun indicum L) in the Sudan Savana zone of Nigeria, during 2020 cropping season at Maiduguri (11^0 50' N, 13^0 10' E, altitude 354 above sea level (asl). The experiment consisted of five (5) nitrogen rates (0, 20, 40, 60 and 80 kgN/ha) and four (4) intra-row spacings (5, 10, 15 and 20 cm). The treatments were arranged in a split plot design laid out in Randomized Complete Block Design Arrangement and replicated three times at each. Nitrogen rates were assigned to the main plot and intra-row spacings in the sub-plot. Growth, yield and yield components were measured, the result showed that application of 40 to 80 kgN/ha resulted in significant increase in the plant height, number of leaves per plant, number of primary branches per plant, number of secondary branches per plant, and number of capsules per plant. While application of 80 kgN/ha consistently significantly increase total dry matter, but similar to when 60 kgN/ha was applied. Higher TDM were recorded was recorded at 80 kgN/ha and widest intra-row spacing of 20 cm at Maiduguri, while application of 20 kgN/ha with 20 cm intra-row spacing increased TDM value. Similarly, grain yield per hectare were at optimum at 60 kgN/ha of nitrogen rate application and maximum grain yield was recorded at 20 cm intra-row spacing . Based on the result of the present study; the growing of sesame with application of 60 kgN/ha at intra-row spacing of 20 cm had greater yield in the Sudan Savannah Zone of Borno State, Nigeria.*

Keyword: *Nitrogen rates, Intra-row spacings, sesame (Sesamun indicum L), sudan savanna*

INTRODUCTION

Sesame (*Sesamun indicum* L.) has been recognized as a crop with a high economic potential in Nigeria, both as a source of raw materials for industries and a reliable foreign exchange commodity (Alegbejo, 2003; NCRI, 2008). Sesame belongs to the family *Pedaliaceae* and is one of the oldest cultivated oilseed crops in the world (Purseglove, 1974). The genus consists of about 36 species of which 19 are indigenous to Africa (Weis, 1983; Uzo, 1998). In Nigeria, three species have been reported to be grown for different purposes namely; *Sesamun alatum*, *S. indicum* and *S. radiatum* (karkashi and kaulubul in Hausa and Kanuri respectively) (Dabir, 2000). The most popular specie is *S. indicum* which has hundreds of varieties and strains with considerable variations in size, form, and growth pattern, color of flowers, seed size, seed color and composition. The crop is known as Beniseed in West Africa (Seegeler, 1989). In Nigeria, it is locally called *Ridi, Ekuku, Isasa and* Moroshi by

Hausa's, Yoruba's, Ibo's and Kanuri's, respectively. It is also known as *til* (Hindi), simsim in Arabic, *huma* (Chinese), *Sesame* (French), *goma* (Japanese), *gergelim* (Portuguese) and *ajonjoli* (Spanish) (Seegeler, 1989).

Sesame is a crop of tropical, sub-tropical and warm temperate regions. Optimum temperatures for growth are between 20^0 C and 24^0 C during vegetative growth and about 27^0 C during flowering and fruiting. The crop is drought tolerant and can grow in areas with annual rainfall between 500 and 1500 mm and soil of medium texture that is well drained and free from salt, with neutral to alkaline (Anon, 2004). In Nigeria the production areas are located within latitudes 7^0 to 14^0, with a dry season that last about 4 to 5 months, and annual rainfall of about 500 to 1500 mm, a vegetation of open savanna woodland and a top soil of sandy loam texture (Van Rheenen, 1973).

In Nigeria, annual production stood at about 300,000 metric tonnes of benni seed in the year 2017 (seed production and export statistic), of which about 50,000 tones was exported (Anon, 2008). Sesame seed contains approximately 50 % oil and 25 % protein and is used in baking, candy making, and in other food industries. Oil from the seed, which contain about 47 % oleic and 39 % linoliec acid, is used in cooking, salad and in making margarine. Sesame oil and food fried in sesame oil have long shelf life because the oil contains an antioxidant called sesamol. The oil can be used in the manufacture of soap, paints, perfumes, pharmaceuticals and insecticides. Sesame meal left after oil extraction is an excellent high crude protein (35 to 50 %) feed for poultry and livestock (Oplinger, 1990).

MATERIALS AND METHODS

Field experiments was conducted during the rainy season of 2020 at the Teaching and Research Farm, Ramat Polytechnic Maiduguri (11^0 50' N, 13^0 10' E altitude 354 above sea level (asl), Maiduguri, Borno State, Sudan Savanna Zone Nigeria. The treatment consists of five (5) Nitrogen fertilizer rates (0, 20, 40, 60 and 80 kg N/ha) and four (4) intra-row spacings (5, 10, 15 and 20 cm). The treatments was laid out in a split plot design and replicated three times each. Nitrogen rates were assigned to the main plots and intra-row spacings to the subplots. A total of 60 plots were used and each measuring 3.0 m x 4.0 m (gross size of 12 m^2), The net plot size of 6 m^2 consists of two (2) most central rows in each gross plot. While the Two boarder rows were used as destructive sampling. Within replicate plots rows was separated at 0.75 m apart walking alley and 1m between each replication. The estimated land area for the experiment was 0.12 ha.

Data Collection

Data for growth and yield and yield component were collected as per procedure mention as follows: Plant height (cm), Number of leaves per plant, Number of primary branches per plant, Number of secondary branches per plant, Total dry matter (TDM) per plant (g), Number of secondary branches per plant, Total dry matter (TDM) per plant (g), Number of capsules per plant, Number of seeds per capsule, 1000- Grain weight (g), Grain yield per plant (g), Grain yield per hectare (kg)

Data analysis:

Data collected was subjected to Analysis of variance (ANOVA) and differences between means were identified using Duncan Multiple Range Test (DMRT) at 5% level respectively as reported by Gomez and Gomez (1984).

Table 4: Effect of rates of Nitrogen fertilizer and intra –row spacings on number of leaves per plant of sesame at Maiduguri and Njimtilo and the combined means during 2014 cropping season

Treatments	Plant height(cm)			Number of leaves/plant		
N-rates (kg ha^{-1})	6WAS	8WAS	10WAS	6WAS	8WAS	10WAS
0	38.5^{c}	44.7^{c}	67.4^{b}	34.73^{b}	51.40^{b}	89.33^{b}
20	43.5^{bc}	54.9^{b}	99.4^{b}	38.51^{ab}	57.81^{a}	109.63^{a}
40	49.1^{ab}	60.1^{ab}	108.5^{a}	41.10^{a}	59.86^{a}	105.78^{ab}
60	49.6^{ab}	62.5^{ab}	112.9^{a}	38.03^{ab}	58.43^{a}	116.40^{ab}
80	51.1^{a}	65.3^{a}	103.1^{a}	43.83^{a}	56.63^{a}	125.93^{a}
SE±	2.76	4.47	9.94	2.56	3.78	13.96
Spacing (cm)						
5	40.3^{b}	49.3^{d}	84.9^{c}	32.02^{b}	48.09^{c}	90.03^{c}
10	43.5^{b}	53.5^{c}	91.6^{b}	34.80^{b}	53.36^{b}	96.28^{c}
15	49.6^{a}	60.3^{b}	105.6^{a}	46.08^{a}	62.66^{a}	119.25^{b}
20	52.1^{a}	66.9^{a}	107.8^{a}	44.06^{a}	63.20^{a}	132.11^{a}
SE	1.63	1.75	3.58	1.42	2.02	5.81
Interaction						
N X S	NS	*	*	NS	*	*

Means followed by the same letters within a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability

Plant height (cm)

Table 2 shows the effect of nitrogen rates and intra-row spacings on plant height per plant of sesame crop. Application of N fertilizer significantly influenced plant height at all the sampling period when 20 and 0 kg N ha^{-1} were applied shows no significant response was observed. it was observed that plant height increased only up to 40 kg N ha^{-1}. Further increase in N beyond the three mention rate did not affect the parameter significantly. The use of different levels of intra- row spacing had significant effect on plant height at all the sampling period. Each increase in intra-row spacing from 5 – 10 cm and further to 15 cm had resulted in a corresponding increase in plant height at all the sampling periods. except at 8 WAS when plant are spaced at 15 cm was not significant.

Number of leaves per plant

The effect of rates of Nitrogen fertilizer and intra-row spacings on number of leaves per plant is presented in Table 1. Number of leaves generally influenced by the application of N fertilizer. Application of 20 kg N ha^{-1} led to significant increase in number of leaves across all the sampling periods statistically similar results was recorded at the applications of 40, 60 and 80 kg N ha^{-1} resulted to a significant improvement in leaf production. Intra-row spacing had significant effect on number of leaves at all the sampling periods. Leaf number was not significantly affected by the increase in intra-row spacing from 5 – 10 cm at 6, 8 and 10 WAS. Further increase in intra-row spacing to 15 cm generally led to production of more leaves. Increase intra-row spacing beyond 15 cm increase leaf number only at 6 8 and 10 WAS in Maiduguri; the parameter was statistically unaffected at other instances.

Table 2: Effect of rates of nitrogen fertilizer and intra row-spacings on number of Primary, secondary branches and TDM per plant at harvest of sesame at Maiduguri during 2014 cropping season

Treatment	NPB	NSP	TDM
N-rates (kg ha^{-1}**)**			
0	2.65^{c}	1.17^{c}	46.38^{c}
20	2.98^{b}	1.41^{b}	88.90^{b}
40	2.89^{b}	1.74^{a}	94.50^{b}
60	3.36^{a}	1.62^{a}	116.14^{a}
80	3.30^{a}	1.75^{a}	123.62^{a}
SE ±	0.06	0.06	5.82
Spacing (cm)			
5	2.30^{c}	1.17^{d}	70.27^{d}
10	2.81^{b}	1.40^{c}	81.78^{c}
15	3.45^{a}	1.69^{b}	111.05^{b}
20	3.57^{a}	1.88^{a}	117.52^{a}
SE ±	0.07	0.05	3.84

Means followed by the same letters within a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability
NPB =Number of primary branches
NSB =Number of secondary branches
TDM= Total dry matter

Number of Primary branches per plant

The effect of nitrogen rates and intra-row spacing on the number of primary branches of sesame was significant (Table 2). Increase in N rates from 0 – 20 kg N ha^{-1} and 40 – 60 kg N ha^{-1} significantly increased number of primary branches per plant at harvest. Application of 60 kg N ha^{-1} did not affect the parameters significantly. N rate at 60 and 80 kg N ha^{-1} had statistically similar. While the control (0 kg N ha^{-1}) significantly produced the lowest number of primary branches per plant at harvest. Intra-row spacing had significant effect on the number of primary branches. Significant increase in number of primary branches per plant was observed with each increases in intra-row spacing from 5 -10 and from 15 -20 cm. However, the intra-row spacing consistently recorded statistically similar and highest number of primary branches per plant at harvest at 15 and 20 cm respectively. The lowest number of primary branches per plant was generally recorded by narrow intra-row spacing of 5 cm. There was no significant interaction between rates of N fertilizer and intra-row spacings. However, the number of secondary branches per plant of sesame was significantly influenced by Nitrogen fertilizer and intra-row spacing (Table 2). application of 40, 60 and 80 kg N ha^{-1} consistently produced statistically similar and more number of more number of secondary branches per plant than 20 and 0 kg N ha^{-1}.it was followed by 20 kg N ha^{-1} while the control (0 kg N ha^{-1}) produced statistically the lowest number of secondary branches. Wider intra-row spacing of 20 cm produced significantly the higher number of secondary branches per plant (1.88), it was followed by 15, 0 and 5 cm in decreasing order. The lowest number of

significantly lowest number of secondary branches in Maiduguri, was from the narrow intra-row spacing of 5 cm (1.17).

Total Dry Matter (TDM) per Plant (g): Total dry matter per plant as significantly influenced by nitrogen rates and intra-row spacings is presented in Table 2. the highest value for total dry matter per plant was reached at highest N rate of 40 - 80 kg N ha^{-1}, The control (0 kg N ha^{-1}) consistently produced the lowest TDM per plant. The highest total dry matter was attained at the wider intra-row spacing of 20 cm at harvest. The lowest TDM were consistently from the 5 cm intra-row spacing

Number of Capsules per Plant

The effect of rates of nitrogen fertilizer and intra- row spacings on number of capsules per plant was significant at Maiduguri and Njimtilo and the combined means (Table 3). Application of 60 and 80 kg N ha^{-1} produced statistically similar, it was followed by 40, 20 and 0 kg N ha^{-1} in decreasing order. while 20 and 40 kg N ha^{-1} had statistically similar and had higher capsule number than the control (0 kg N ha^{-1}) produced lowest number of capsules per plant. Intra-row spacing had significant effect on number of capsules per plant with widest intra-row spacing of 20 cm having the highest number of capsules per plant. It was followed by that from 15 and 10 cm intra row spacing but statistically the same. Significantly lowest number of capsules per plant was recorded when sesame is spaced at either 5 cm spacing.

Number of Grains per Capsule: shows the effect of treatments on number of grains per capsule of sesame at Maiduguri. The number of grains per capsule was not significantly influenced by the application of nitrogen fertilizer. The wider intra-row spacing of 20 cm produced statistically the highest number of grains per capsule. Planting sesame at 5 cm intra-row spacing produced significantly the lowest number of grains per capsule.

1000- Grain Weight (g)

The response of 1000- grain weight of sesame to rates of nitrogen fertilizer and intra-row spacing is presented in Table 3. The 1000-grain weight was not significantly influenced by the application of N fertilizer. Intra-row spacing generally had significant effect on 1000-grain weight. The intra-row spacing of 20 cm produced statistically similar 1000- grain weight that from 15 and 10 cm narrow intra-row spacing but more than that from 5 cm. Values recorded by 5, 10 and 15 cm intra-row spacings were statistically at par.

Grain yield per plant (g)

The significant effect of nitrogen fertilizer and intra-row spacing on grain yield per plant of sesame during 2020 cropping season at Maiduguri is presented in Table 3. The response of the parameter to application of N were inconsistent. that highest grain yield per plant was attained at the highest N rate of 80 kg N ha^{-1}. It was followed by 60 kg N ha^{-1}, 20 kg N ha^{-1} and 40 kg N ha^{-1} while the lowest grain yield per plant (3.92 g) from the control (0 kg N ha^{-1}).

Intra-row spacing had significant effect on grain yield with wider intra-row spacing of 20 cm producing the highest grain yield per plant. But statistically similar values were recorded at 15,10 and 5cm respectively

Table 3: Effect of rates of Nitrogen fertilizer and intra-row spacing on yield and yield components of sesame during 2020 cropping season at Maiduguri

Treatment	NCPP	NGPC	1000GW	GYPP	GYPH	FYPH
N-rates (kg ha^{-1}**)**						
0	30.62^{d}	48.50	3.09	3.91^{c}	268.60^{b}	245.00
20	42.30^{c}	47.90	3.17	5.14^{b}	349.53^{b}	335.83
40	51.30^{bc}	50.20	3.11	4.93^{b}	610.37^{a}	336.25
60	57.33^{ab}	49.90	3.11	5.25^{b}	622.97^{a}	329.58
80	60.87^{a}	48.40	3.13	5.84^{a}	699.98^{a}	314.17
SE±	3.53	1.09	0.03	0.14	39.34	47.01
Spacing (cm)						
5	44.17^{c}	40.00^{c}	3.06^{b}	4.21^{b}	460.20^{b}	199.70^{d}
10	46.81^{bc}	42.90^{c}	3.13^{ab}	4.30^{b}	490.11^{ab}	251.33^{c}
15	49.80^{b}	51.97^{b}	3.13^{ab}	5.62^{a}	537.29^{ab}	346.33^{b}
20	53.90^{a}	60.86^{a}	3.17^{a}	5.91^{a}	553.55^{a}	447.33^{a}
SE	1.74	1.65	0.01	0.20	26.22	22.46

Means followed by the same letters within a column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level of probability

NCPP =Number of capsule per plant **NGPC =Number of grain per capsule**

1000GW= thousand grain weight **GYPP = grain yield per plant**

GYPH = grain yield per hectare **FYPH = fodder yield per hectare**

Fodder yield per hectare (kg ha^{-1})

The effect of treatments on fodder yield per hectare at harvest showed that there was no significant effect of nitrogen fertilizer on fodder yield at Maiduguri (Table 3). Intra– row spacing had significant effect on fodder yield per hectare in Maiduguri. The widest intra-row spacing of 20 cm produced the highest fodder yield as compared to all the spacing tested 5, 10 and 15 cm intra-row spacing's (Table 3). It was followed by 15 cm intra- row spacing while the lowest fodder yield was generally from 5 cm intra-row spacing.

DISCUSSION

Response to Nitrogen fertilizer

The result of this study shows that application of Nitrogen significantly influenced all the yield, growth and yield components of sesame, number of capsules per plant, weight of grain per plant and 1000-grain weight which did not respond to application of N fertilizer. The positive response of most of the measured growth and yield character to applied N fertilizer was expected. This is due to the fact that crop is known to respond positively to N fertilizer in soil with low N content as is the case for that which the experiment was conducted. Likewise crops also respond to N application because of the role play by N in growth and development of plant. Nitrogen is a constituent of chlorophyll, nucleic and amino acid and thus play an important role in photosynthesis; the process that produce assimilates use for the development of different plant organ and hence result in increased growth (Das, 2009). It was also generally observed that the response of the crop to N application varied or are similar for some of the parameters between locations tested. This is not surprising for some of the variation that existed in both the soil and micro-climate between the two experimental locations, hence the difference in crop performance. The increased values for number of primary and secondary branches and total dry matter as well as, plant height with intra-row spacing could be probably due to the fact that, sesame plants grown at wider intra- row spacing of 15 and 20 cm are less exposed to intra specific competition for light, nutrient, moisture and space, due to fewer plant stands, therefore, tend to grow more vigorously as compared with narrower intra-row spacing of 5 and 10 cm which tend to exert pressure on scarce growth resources such as light, space, moisture and nutrients as a result of higher plant population per unit area thereby leading to poor growth. This is in harmony with the findings of Umar *et al*, (2010), Samson, (2005), Caliskan *et al*, (2004), Ngala *et al* (2013); and Gupta, (1982). Who reported a significant increase in number of branches and TDM per plant at wider intra- row spacing of 15 cm than 10cm.

Conclusion

Based on the results obtained in this study, it can be concluded that application of 60 kg N ha^{-1} at wider intra-row spacing of 20 cm gave the optimum grain yield per hectare of sesame, in Sudan savanna zone of Nigeria.

Recommendation

From the study, it could be recommended that farmers should be advised to apply 60 kg N ha^{-1} and use wider intra-row spacing of 20 cm for optimum sesame grain yield per hectare. Further research work should be pursued to ascertain the results obtained in the present study

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