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Growth and Yield of Sesame (*Sesamum indicum* L.) as influenced by Nitrogen and Intra row spacing in Lafia, Nasarawa State of Nigeria

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ABSTRACT

Field trial was conducted during the rainy seasons of 2009 and 2010 to study the effects of nitrogen and intra row spacing on the growth and yield of sesame. The experiment consisted of three levels of nitrogen in the form of urea (0, 50, and 100 kg N ha^{-1}) and three intra row spacing (7.5, 15 and 22.5cm). The nine treatment combinations were laid out in a randomized complete block design with three replications. Plant height, leaf area index, number of branches per plant, total dry matter per plant and days to 50% flowering were optimized at 100 kg N ha^{-1} and 22.5cm intra row spacing. Numbers of capsules per plant, capsule weight per plant, grain yield per plant and grain yield per hectare were optimized at 50 kg ha^{-1} of nitrogen. Maximum number capsules per plant, capsule weight per plant, grain yield per plant were recorded at 22.5cm intra row spacing while, maximum grain yield per hectare was recorded at 15cm intra row spacing. Application of 50 kg N ha^{-1} and planting at 15cm intra row spacing is therefore recommended for higher sesame yield in this area.

Introduction

Sesame (*Sesamum indicum* L.) belong to the family *pedaliaceae* and is one of the most ancient oil crops in the world (Weiss, 1984; Ram *et al*., 1990). It is grown in both tropical and sub-tropical regions of Africa, Asia and Latin America. India and Ethiopia have both been proposed as sesame's centre of origin, but presently, the opinions are more in favour of Ethiopia because it is believed to have spread from there to other parts of Africa, India, China, Japan and Europe in very early times (Weiss, 1984). It is the most important crop from which semi-drying vegetable oils are obtained and perhaps the oldest crop cultivated for its oil (Onwueme and Sinha, 1991).

Sesame has gained considerable importance in Nigeria due to its economic value and especially export potential. In Nigeria, Sesame is produced mainly in the savanna agro-ecological zones extensively by small holders using manual labour and limited inputs, without optimum plant population and on relatively poor soils thereby resulting in low average yield of 300 kg ha^{-1} compared with 1,960 kg ha^{-1} in Venezuela, 1083 kg ha^{-1} in Saudi Arabia, 517 kg ha^{-1} in Ivory Coast and 510 kg ha^{-1} in Ethiopia (Abubakar *et al*., 1998).

Of all the essential elements, nitrogen exerts the most pronounced effect on plant growth and yield. It plays a vital role in protein synthesis, is a constituent of enzymes and chlorophyll molecules. It is involved in all processes associated with protoplasm, enzyme reaction and photosynthesis (Anon., 1999). According Subramanian and Kulandaiveiv (1997), application of 45 kg N ha^{-1} increased seed yield of sesame. In their study, Olowe and Busari (2000) reported an increased in plant height at maturity from 104.6 cm with 0 kg N ha^{-1} to 122.9 cm with the application of 90 kg N ha^{-1}, they also found that application of 60 kg N ha^{-1} produced the highest number of capsules per plant, capsule weight per plant and grain yield per hectare. In a similar study Malik *et al*. (2003) reported a significant increased in plant height from 127.48 cm with zero kg N ha^{-1} to 136.37cm with the application of 80 kg N ha^{-1}. Working on the effects of nitrogen and phosphorus fertilizer rates on the growth and yield of sesame in eastern Nigeria, Okpara *et al*. (2007) found that application of 75 kg N ha^{-1} significantly increased growth characters of sesame such as plant height, number of leaves per plant and shoot dry matter while the yield and yield attributes were significantly increased by the application of 50 kg N ha^{-1}. This indicates that different rates of N are required for growth and yield attributes.

The predominance of the broadcast sowing method in the major sesame producing areas in Nigeria, particularly in the north central zone makes it difficult for farmers to attain the optimum plant population required for maximum yield because seeds are not broadcast evenly broadcasted evenly. (Haruna and Alhassan, 2005). Among agronomic practices, plant density plays a vital role in influencing the growth and yield of sesame (Nantongo, 2002).Various workers have reported different intra row spacing for higher yield in sesame, for instance, Gnanamurthy *et al.*, (1992) observed that yield of sesame varied with plant density, with high and low plant populations decreasing yield significantly.

On the other hand, Ssekabembe *et al*., (2002) indicated that sesame yields increased with increase in plant population. Ashgar *et al*. (2003); Ojikpong, *et al*., (2007) reported that an intra row spacing of 10cm gave highest values for number of capsules per plant, seed weight per plant and 1000-seed weight. Bonsu (2003) reported that planting sesame at (7.5 x 60 cm and 15.0 x 60 cm) increased the leaf area index, crop growth rate and shoot dry matter production but not plant height and final seed yield. The number of branches per plant, the number of podding nodes per plant, the number of pods per plant and the number of mature seeds per pod decreased with close planting (7.5 x 60 cm and 15.0x60 cm).

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Work on the effect of nitrogen and intra row spacing on the growth and yield of sesame in this part of the country is lacking. This work therefore seeks to assess the growth and yield of sesame as influenced by nitrogen and intra row spacing.

Materials and Methods

Field experiments were conducted at the research farm of College of Agriculture Lafia in the Southern guinea savanna zone of Nigeria (08^0 $30^/$ N and 08^0 $30^/$E, 18m above sea level) on a sandy soil (0.02% N total) during the rainy seasons of 2009 and 2010 to assess the growth and yield of sesame under varying nitrogen rates and intra row spacing. The experiment consisted of three levels of nitrogen in the form of urea (0, 50 and 100 kg N ha^{-1}) and three intra row spacing (7.5, 15 and 22.5cm). The nine treatment combinations were laid out in a randomized complete block design with three replications. The gross plot size was $18m^2$ (4.5m x 4m) while the net plot size was $9m^2$ (3m x 3m).

The experimental area was disc-ploughed and harrowed twice to a fine tilt. This was then followed by ridging at 75cm apart (between rows) and the field marked into plots and replications. The plots were separated by 1.0m unplanted boarder while replications were separated by 2.0 m unplanted boarder. The planting material used was Ex-Sudan, it is white in colour, of medium height (cm) and medium maturity (85 to 90 days) (RMRDC, 2004). Sowing was done on ridges 75cm apart at 7.5, 15 and 22.5cm intra row spacing according to field plan and treatment combinations. Half of the nitrogen levels were applied at 3 weeks after sowing (WAS) while the remaining half was applied at 6 WAS. Manual hoe weeding was done at 3, 6, and 9 WAS to keep the experimental plots weed-free.

The crop was harvested when the leaves and the stems changed colour from green to yellow with reddish spots on them. Growth parameters like plant height, leaf area index, number of branches per plant and total dry matter per plant, were collected from five randomly selected tagged plants in each plot and the mean recorded. Number of days to 50% flowering was determined by counting the number of days from sowing to when half of the plant in a plot have flowered. Yield data per plant such as number of capsules per plant, capsule yield per plant and seed yield per plant, were collected from ten randomly selected tagged plants in each plot and the mean recorded. The grain yield per hectare was collected from the four inner rows (net plot) and the value obtained, was converted to per hectare basis.

The data collected were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran (1967) and significant differences among the treatment means were evaluated using Duncan's Multiple Range Test as described by Duncan (1955).

Results

Each increase in the rate of applied nitrogen significantly increased plant height, leaf area index, number of branches per plant and total dry matter per plant (Table 1). The tallest plant, the highest LAI, the highest number of branches per plant and TDM per plant was obtained with the application of 100 kg N ha^{-1} while the control plots without nitrogen produced the lowest values for all the growth chacters measured. Plots without nitrogen were the the first to flower followed by those with 50 kg N ha^{-1} while, plots that recieved 100 kg N ha^{-1} were the last to flower.

Similarly, each increase in intra row spacing significantly increased plant height, LAI, number of branches per plant and TDM per plant (Table 1). An intra row spacing of 30cm produced the tallest plant and plants with the highest LAI, number of branches per plant, TDM per plant while, the shortest plant and plants with the lowest LAI, number of branches per plant, TDM per plant were produced by an intra row spacing of 7.5cm. plants spaced at 7.5cm were the first to flower while those planted at an intra row spacings of 15 and 30cm were the last to flower. Application of 50 kg N ha^{-1} produced significantly higher number of capsules per plant, capsule weight per plant, grain yield per plant and grain yield per hectare compared with the controlled plots (Table 2). Increasing the rate of applied nitrogen from 50 to 100 kg ha^{-1} significantly decreased number of capsule per plant, capsule weight per plant, grain yield per plant and grain yield per hectare. Sesame planted at 30cm intrar row spacing produced significantly higher number of capsule per plant, capsule weight per plant and grain yield per plant compared with those planted at 7.5 and 15cm intra row spacings (Table 2). The highest grain yield per hectare was produced by 15cm intra row spacing while the least grain yield per hectare was produced by 7.5cm spacing.

Discussion

The response exhibited by sesame to nitrogen application as observed in increased plant height, LAI, number of branches per plant and the total dry matter per plant in all seasons could be attributed to the ability of N in promoting vegetative growth. It could also be attributed to the fact that N is an important constituent of chlorophyll, amino acid and nucleic acid, hence its essentiality in plant's growth and development (Brady, 1984). This is in conformity with the findings of Hossein *et al.* (1985) and Okpara *et al.,* (2007), who reported significant increase in such growth characters of sesame due to applied N. Number of days to 50% flowering was increased with nitrogen application. This could be attributed to the fact that nitrogen have been reported to increase leaf size and chlorophyll content, delayed maturity time and increased vegetative growth period (Haruna *et al*., 2011).

Sesame planted at an intra row spacing of 7.5cm were shorter, having lower LAI, TDM and number of branches per plant compared with those planted at wider spacing. This could be due to the fact that at closer spacing, there was more number of plants per unit area compared with wider spacing hence; there was competition for space, light and nutrients. At wider spacing, the number of plants per unit area was few and the competition for space, light and nutrients was low thereby producing taller plants with higher LAI, TDM and number branches per plant.

Yield components such as number of capsule per plant, capsule yield per plant, seed yield per plant and seed yield per hectare were all optimized at moderate N level (50 kg N ha^{-1}) and not the highest N level (100 kg N ha^{-1}) as in growth characters. This could be because excessive nitrogen has been reported to reduce fruit number and yield but enhances plant growth (Aliyu *et al*., 1996). This finding corroborated those of Roy *et al*. (1995), Gnanamurthy *et al*. (1992), Osman, (1993), Olowe and Busari (2000), Okpara *et al*. (2007), Fathy and Mohammed (2009), Haruna *et al*. (2010).

The highest number of capsules per plant, capsule weight per plant and seed yield per plant recorded at 30cm intra row spacing compared with those recorded at 7.5 and 15cm could be attributed to the fact that at these spacing, plant population per unit area is low, competition that existed between the plants is

low hence, the plant utilized the available nutrients, light and space maximally and effectively. However, the highest grain yield per hectare was not recorded at 30cm spacing but at 15cm intra row spacing probably because of the higher plant population at 15cm spacing.

Conclusion and recommendation

From the foregoing, it can be concluded that the growth characters of sesame measured were optimized at 100 kg N ha^{-1} and 30cm intra row spacing while, the grain yield per hectare was optimized at 50 kg N ha^{-1} and 15cm intra row spacing. Application of 50 kg N ha^{-1} and planting at 15cm intra row spacing is therefore recommended for higher sesame yield in this area.

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Table 1: Effects of nitrogen and spacing on the growth characters of sesame at Lafia, Nigeria (data pooled for 2009 - 2010).

Treatment	Plant height (cm)	Leaf area index	Number of branches	Total dry matter (g)	Days to 50% flowering
Nitrogen (kg ha^{-1})					
0	85.48c	0.29c	3.29c	18.72c	37.54c
50	101.62b	0.49b	6.36b	25.20b	41.95b
100	116.73a	0.78a	8.76a	32.75a	43.56a
SE±	0.130	0.020	0.100	0.130	0.160
Spacing (cm)					
7.5	92.46c	0.39c	3.51c	19.44c	40.30b
15	103.46b	0.56b	6.67b	24.74b	41.31a
30	107.92a	0.62a	8.22a	32.48a	41.44a
SE±	0.130	0.020	0.100	0.130	0.160
Interaction					
N X S	NS	NS	NS	NS	NS

Means folowed by the same letter (s) within the same treatment group and column are not statistically different at 5% level of probability.

Table 2: Effects of nitrogen and spacing on the yield and yield attributes of sesame at Lafia, Nigeria (data pooled for 2009 - 2010)

Treatment	No. of capsule plant^{-1}	Capsule yield plant^{-1} (g)	Grain yield plant^{-1} (g)	Grain yield ha^{-1} (kg)
Nitrogen (kg ha^{-1})				
0	28.75c	8.01c	3.48c	572.80c
50	83.80a	21.33a	8.16a	888.04a
100	54.87b	18.43b	5.99b	707.04b
SE±	0.230	0.200	0.167	2.459
Spacing (cm)				
7.5	31.15c	12.62c	3.61c	578.00c
15	66.90b	16.93b	6.48b	895.36a
30	69.37a	18.22a	7.54a	694.56b
SE±	0.230	0.200	0.167	2.459
Interaction				
N X S	NS	NS	NS	NS

Means folowed by the same letter (s) within the same treatment group and column are not statistically different at 5% level of probability.