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Sesame (*Sesamum indicum. L)* Growth, Yield, Yield Components and Weed Infestation as Influenced by Sowing Method and Different Seed Rates in a Sudan Savanna Agro-Ecology of Nigeria I

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Abstract: The influence of seed rates and sowing methods of planting on sesame *(Sesamum indicum.* L) growth, yield, yield components and weed infestation was conducted at Maiduguri Nigeria, during the 2001 and 2002 rainy seasons. Results showed that broadcast method of sowing produced taller plants in 2002 and the average of two years data, pods per plant compared with drilling method in both years and the average of two years data. Similarly, plant height, number of flowers and pods per plant decreased with increase in seed rate with 15 kg ha^{-1} seed rate producing significantly lowest of these characters in 2001 and the average of two years data. Broadcast method of sowing produced significantly higher weed cover and weed dry matter in 2001, 2002 and average of two years data compared with drilling method. Also, the amount of weed dry matter and weed cover decreased with increase in seed rate up to 12 kg $ha^{1}$and 15 kg ha^{-1} seed rate producing the highest weed cover and weed dry matter in 2001, 2002 and the average of two years data. Drilling method of sowing produced the higher yield compared with broadcast method although the difference was not significant. Similarly, seed rate of 6 kg ha^{-1} produced the highest seed yield ha^{-1} compared with higher seed rates in the two years and it is only in the average of the two years data that differences in yield was significant. Therefore, for better sowing method and optimum yield, drilling method and 6 kg ha^{-1} seed rate are, respectively recommended for Maiduguri situated in a Sudan Savanna agro-ecology of Nigeria.

Key words: Sesame growth, drilling method, plant height, weed dry matter, sowing, weed infestation

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an oil crop grown in about 15 out of the 36 States of Nigeria stretching from the north east, north central, the middle belt and Federal capital Territory of the Sudan and Guinea Savannas (Philips, 1977; Ingawa *et al.*, 1986). It is an important crop because the seed contains about 51% oil, 17-19% protein and 16-18 % carbohydrate (Yermanos *et al.*, 1972). Sesame oil is used for the manufacture of margarine, salad oil, cooking oil, soap, paints, lubricants and lamp fuel. Ryu *et al.* (1972) reported that sesame oil contains sesamoline and sesamine which is used as synergist for insecticides.

The effect of plant population on yield and yield components have been reported by several workers. Seed yield per unit area increases with increased population density from 80,000-160,000 plants ha^{-1} and beyond this density it becomes counter productive (Delgado and Yermanos, 1975). Also increased number of seeds per capsule, number of capsules per plant and dry matter production increased when the intra-row spacing increased from 30-90 cm (Weiss, 1983; Olowe and Busari, 1994).

As regards weed control, row planting is superior to broadcasting, resulting in increased yield (Weiss, 1971) while wide spacings favour higher weed competition in crops (Akobundu, 1987).

The production of sesame has been remarkable in the middle belt of the southern Guinea Savanna of Nigeria, but no work have been carried out on sesame either as a sole crop or main crop in Maiduguri situated in the Sudan Savanna agro-ecology of Nigeria. Groundnut, also an oil seed crop has recorded a decline in production over the years. This trend has given sesame a place as an alternative oil seed crop useful as raw material in agro-allied and other industries. Since there is paucity of research on sesame in the Sudan Savanna agro-ecology, it was necessary to conduct this study in Maiduguri with the objective of determining the influence of sowing methods and seed rates on sesame growth, yield, yield components and weed infestation.

MATERIALS AND METHODS

The experiment was conducted during the 2001 and 2002 rainy seasons (July-October) on Teaching and Research Farm, Faculty of Agriculture, University of

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Maiduguri, Maiduguri ($11^0$51'N, $13^0$15'E). The physico-chemical analyses of the soils of the experimental sites are presented in Table 1. The total amount of rainfall for 2001 and 2002 were 727.7 and 494.7 mm, respectively.

The experiment consisted of 10 treatments which included two sowing methods (Broadcast and Drilling at 90 cm inter-row) and 5 seed rates (3, 6, 9, 12 and 15 kg ha^{-1}). The experiment was laid out in a split-plot design replicated 3 times, where the method of planting was allocated to main plots and seed rate was allocated to sub plots. The experiment site was harrowed, leveled properly using a hand-hoe and marked out. The size of each sub plot measured 6×8 m leaving a distance of 1m between replications and 0.5 m between main and sub plots. Fertilizer at the rate of 75 and 50 kg P ha^{-1} was applied to each plot in two equal split does, first at planting and the second dose at 6 Weeks After Sowing (WAS). For the second dose, fertilizer was broadcast on the plots of the broadcast seeds, while it was placed 15 cm away from the stand in a continues band in the drilled plots. Sesame variety Gwoza local was sown on 20 and 27th of July, 2001 and 2002 at Maiduguri. Weeding of the plots by a simple hand hoe was carried out at 3 and 6 WAS, while thinning was not carried out.

Only the four inner rows of each plots in the drilled method of planting were harvested, while in the broadcast method a margin of 1.65 m was left out on either side of each plot and the inner crop was harvested. The first and last rows of each drilled plot were discarded. Observations taken include, plant height, number of flowers/plant, weed cover, weed dry matter production and seed yield. All data were subjected to Analysis of Variance (ANOVA) and the Duncan's Multiple Range Test (DMRT) was used to compare means at 5% level of probability as reported by Gomez and Gomez (1984).

Table 1: Physico chemical properties of the soil collected from the experimental sites at Maiduguri, Borno State, 2001 and 2002

	Composition	
Soil characteristics	2001	2002
% Sand	64.90	57.80
% Silt	19.65	25.70
% Clay	15.45	16.50
Textural class	Sandy loam	Sandy clay loam
Chemical properties		
pH (H_20)	5.37	5.66
Carbon (%)	0.29	0.61
Organic matter (%)	0.50	1.05
Available P_2O_5(p.p.m)	143.5	112
Total nitrogen (%)	0.056	0.06
Exchangeable cations meq 100 g^{-1} soil		
Ca	1.65	1.14
Mg	1.08	1.42
K	0.27	0.26
Na	4.40	3.78
CEC	8.22	7.45

RESULTS AND DISCUSSION

Table 1 shows the physico-chemical characteristics of the soil of the experimental site. The soil was sandy loam, moderate acidity with medium organic matter content and low exchangeable cations. Sowing method did not significantly affect plant height of sesame in 2001 and 2002 (Table 2). However, drilling method produced taller plants in 2001, while broadcast method produced taller plants in 2002 and the average of the two years (Table 2).

In 2001 and the average of two years, plant height decreased plant with increase in seed rate with 3 kg ha^{-1} seed rate producing the tallest plants. However, in 2002, plant height increased with seed rate up to 6 kg ha^{-1} and further increase beyond this seed rate led to decrease in plant height (Table 2). In the two years and their average, 15 kg ha^{-1} seed rate produced the shortest sesame plants which was significant in 2002 and the average of two years data compared with the lower seed rates (Table 2). The interaction between seed rate and sowing method on sesame plant height was not significant (Table 2).

Table 2: Effect of sowing method seed rate and on plant height (cm) at harvest and number of flowers/plant at 10 WAS at Maiduguri in 2001 and 2002

	Plant height(cm)			Number of flowers per plant		
Treatment	2001	2002	Mean[1]	2001	2002	Mean
Sowing Method (SM)						
Drilling	138.4a	133.8a	136.1a	34.3a	30.0a	32.2a
Broadcast	133.4a	145.9a	140.0a	35.8a	46.7a	41.3b
SE (±)	3.06	3.03	1.45	3.63	5.18	1.90
Seed Rate (SR) kg ha^1						
3	141.4a	145.3ab	143.3a	35.7a	45.5ab	40.6a
6	139.7a	146.2a	143.0a	34.1a	48.9a	41.5a
9	136.2a	133.3bc	140.8a	39.0a	34.7bc	36.9b
12	137.1a	144.5ab	134.8ab	36.6a	36.4bc	36.5ab
15	125.2a	129.7c	127.5b	29.9a	26.3c	28.1b
SE(+)	6.39	5.68	4.32	5.75	5.16	4.84
Interaction						
SM×SR	NS[3]	NS	NS	NS	Sig[4]	NS

1 = Average of two years data. 2 = Means followed by the same letters are not significantly different at 5% level of probability Duncan's Multiple Range Test according to (DMRT). 3 = Not significant. 4 = Significant at 5% level of probability

In 2001 and 2002 and the average of the two years data, broadcast method of sowing produced higher number of flowers at 10 WAS compared with drill method (Table 2). The number of flowers produced by broadcast method in the average of the two years data was significantly higher compared with drill method (Table 2).

The number of flowers produced per sesame plant decreased with increase in seed rate in 2001 with 9 kg ha^{-1} producing the highest number of flowers. However, the difference in the number of flowers produced at different seed rates was not significant. In 2002 and the average of the two years data, the number of flowers per plant increased with increase in seed rate peaking at 6 kg ha^{-1} and declined with further increase in seed rate with 15 kg ha^{-1} seed rate producing significantly fewer number of flowers per plant compared with the 3 kg and 6 kg ha^{-1} seed rates (Table 2). This could be due to greater inter and intra plant competition.

The interaction between sowing method and seed rate on number of flowers per plant was significant in 2002 (Table 3). Broadcast method at 6 kg ha^{-1} seed rate produced significantly highest number flower compared with drilling method at all the tested seed rates. It also produced significantly higher number of flowers compared with other broadcast seed rates except at 9 and 15 kg ha^{-1} seed rates (Table 3).

Table 3: Interaction between sowing method and seed rate of sesame on number of flowers per plant at Maiduguri, 2002

Sowing method/seed rate	Number of flowers/plant at 10 WAS[1]
Drilling×3 kg ha^{-1}	33.1 b[2]
Drilling×6 kg ha^{-1}	39.4b
Drilling×9 kg ha^{-1}	36.8b
Drilling×12 kg ha^{-1}	20.9c
Drilling×15 kg ha^{-1}	19.9cd
Broadcast×3 kg ha^{-1}	57.9a
Broadcast×6 kg ha^{-1}	58.4a
Broadcast×9 kg ha^{-1}	32.7b
Broadcast×12 kg ha^{-1}	51.9a
Broadcast×15 kg ha^{-1}	32.7b
S.E (+)	5.15

1 = Weeks after sowing. 2 = Means followed by the same letter(s) within a column are not significantly different at 5% level of probably using Duncan's Multiple Range Test (DMRT)

In 2001, 2002 and the average of the two years data, broadcast method of sowing produced more weed cover than the drilling method. However in 2002, the weed cover under broadcast method, was significantly more than under drilling method (Table 4).

In the two years and the average of two years data, weed cover decreased with increase in seed rate at harvest up to 9 kg ha^{-1} seed rate (Table 4). Fifteen kg ha^{-1} produced the highest weed cover in both years and in the average of the two years data compared with lower seed rates. The interaction between seed rate and sowing method on weed cover was not significant at harvest (Table 4).

Similarly, in 2001, 2002 and the average of the two years data, broadcast method produced the highest weed dry matter compared with drilling method. Also the amount of weed dry matter decreases with increase in seed rate up to 12 kg ha^{-1} with 15 kg ha^{-1} producing the highest weed dry matter in 2002 and in the average of the two years data (Table 4). The interaction between seed rate and sowing method on total weed dry matter was not significant (Table 4).

There was no significant difference in the number of ponds produced by the two sowing methods at 12 WAS (Table 5). However, broadcast method of sowing produce higher number of pods compared with drilling method in 2001, 2002 and the average of the two years data (Table 5).

In 2001 the number of pods increased with increase in seed rate up to 9 kg ha^{-1} and beyond this rate there was a decline in number of pods with no significant difference among the number of pods produced. In 2002 and the average of the two years data the number of pods produced per plant increased with increase in seed rate

Table 4: Effect of seed rate and sowing method on weed cover and total weed dry matter in 2001 and 2002

	Weed cover Scores[1]			Total weed dry matter (kg ha^{-1})		
Treatment	2001	2002	Mean	2001	2002	Mean
Sowing method						
Drilling	4.7a[2]	5.5b	5.1a	106.7a	203.0a	154.9a
Broadcast	5.8a	7.2a	6.5a	118.0a	225.5a	171.8a
S.E (±)	0.73	0.37	0.40	25.04	49.79	22.31
Seed Rate (SR) kg ha^{-1}						
3	5.7a	6.8a	6.3ab	121.7a	221.1a	171.4a
6	4.7a	6.3a	5.5bc	115.0a	211.1a	163.0a
9	4.2a	5.5a	4.8c	100.0a	214.3a	157.2a
12	5.3a	5.6a	5.5bc	110.0a	166.6a	138.3a
15	6.3a	7.5a	6.9a	115.0a	258.3a	186.7a
SE (±)	1.10	0.80	0.67	39.60	59.74	141.80
Interaction						
SM×SR	NS[3]	NS	NS	NS	NS	NS

1= On a scale of 0 to 10 where 0 = no weed cover and 10 = complete weed cover. 2= Mean followed by the same letter (s) within a column is not significant at 5% level of probability according to Duncan's Multiple Range Test (DMRT). 3 = Not significant

Table 5: Effect of seed rate and sowing method on number of pods per plant at 12 W.A.S. and grain yield in 2001 and 2002

	Number of pods per plant			Grain yield (kg ha^{-1})		
Treatment	2001	2002	Mean[1]	2001	2002	Mean
Sowing method						
Drilling	116.2a[2]	48.8a	82.5a	553.8a	398.5a	476.2a
Broadcast	124.4a	93.4a	108.9a	422.1a	311.6a	366.8a
S.E (±)	12.20	12.49	10.82	62.20	62.94	37.33
Seed Rate (SR) kg ha^{-1}						
3	127.3a	90.6ab	109.0ab	565.7a	383.4a	476.0ab
6	138.6a	103.4a	121.0a	611.4a	453.1a	532.3a
9	139.6a	56.9bc	98.3bc	475.8a	330.3a	403.0ab
12	100.2a	54.5bc	77.4cd	394.1a	201.5a	297.8b
15	95.5a	50.0c	72.8d	389.8a	406.8a	398.3ab
SE (±)	19.22	9.98	10.40	98.35a	110.77	74.50
Interaction						
SM×SR	NS[3]	NS	NS	NS	NS	NS

1 = Average of two years data. 2 = Means in a column followed by the same letter(s) are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT). 3 = Not significant

peaking at 6 kg ha^{-1} seed declined thereafter with further increases in seed rate (Table 5). In 2002 and the average of the two years data, 6kg/ha seed rate produced significantly highest number of pods compared with higher tested seed rates (Table 5). The interaction between the sowing method and seed rate on number of pod/plants was not significant (Table 5).

There was no significant difference in the number of pods produced by the two sowing methods at 12 WAS (Table 5). However, broadcast method of sowing produce higher number of pods compared with drilling method in 2001, 2002 and the average of the two years data (Table 5).

In 2001, the number of pods increased with increase in seed rate up to 9 kg ha^{-1} and beyond this rate there was a decline in number of pods with no significance difference among the number of pods produced. In 2002 and the average of the two years data the number of pods produced per plant increased with increase in seed rate peaking at 6 kg ha^{-1} seed and declined thereafter with further increases in seed rate (Table 5). In 2002 and the average of the years data, 6 kg ha^{-1} seed rate produced significantly highest number of pods compared with higher tested seed rates (Table 5). The interaction between the sowing method and seed rate on number of pods per plants was not significant (Table 5).

Drilling method produced higher seed yield per hectare compared with broadcast method in 2001, 2002 and the average of the two years data. However, the difference in yield between the two methods of sowing was not significant (Table 5).

In both years and their average, seed yield per hectare increased with increase in seed rate peaking at 6 kg ha^{-1} and declined thereafter with further increases in seed rate (Table 5). While the difference in seed yield per hectare in 2001 and 2002 at different seed rates per hectare was not significant, 3 kg ha^{-1} and 6 kg ha^{-1} seed rates under average of the two years data produced significantly higher seed yield compared to higher sewed rates (Table 5).

The interaction between seed rate and sowing method on the seed yield was no significant (Table 5).

Sowing method had no significant effect on plant height in 2001 and 2002. The taller plants produced by the drilling method compared with the broadcast method in 2001 could be due to greater intra and inter plant competition for nutrients and moisture in broadcast plots compared with drilled plots, while the taller plants produced under broadcast method in 2002 could be due to competition for light (Mazzani and Cobo, 1956; Donald, 1965; Weiss, 1983; Van Rheenen, 1973; Delgado and Yermanos, 1975; Ndarubu *et al*., 1996), who reported increase in plant height with decreased intra and inter-row spacing.

Similarly, in both years and their combined analysis, sesame plant height decreased with increase in seed rate with 15 kg ha^{-1} seed rate producing significantly the shortest plants compared with lower seed rates of 3 kg ha^{-1} and 6 kg ha^{-1}. The reduction in plant height with increase in seed rate could be due to increased inter and intra plant competition for growth resources of soil moisture and nutrients. This is similar to the findings of Anonymous (1966) who reported a marked tendency towards stunted growth at a very close intra-row spacing of sesame.

At 10 WAS in 2001 and 2002 broadcast method produced higher number of flowers than drilling method, although the difference in the number of flowers produced between the two sowing methods was significant only in the combined analysis. This could be due to intra -plant competition in the drilled crop compared with the broadcast crop (Imoloame, 2004).

Generally, the number of flowers decreased with increase in seed rate. Although there was no significant

difference in the number of flowers produced per plant at different seed rates, 6 kg ha^{-1} seed rate produced the highest number of flowers in 2002 and the combined analysis compared with higher seed rates. This could be due to greater inter and intra plant competition for soil nutrient, moisture and space at higher seed rates. This agrees with the findings of Olowe and Busari (1994) who reported that plant in wide rows are exposed, to less intra-specific competition and tend to be most vigorous and productive. The interaction between seed rate and sowing method on the number of flower per plant was significant. Broadcast sesame crop at 3, 6 and 12 kg ha^{-1} produced significantly higher number of flowers compared with drilling method at all the seed rates tested. This could be due to intra-plant competition for growth resource and space under drilling method compared with broadcast method. Sowing method did not significantly affect the number of pods per plant. The greater number of pods produced by broadcast method compared with drilling method could be due to early intra-plant competition for growth resources of moisture and space under the drilling method compared with the broadcast method. The number of pods per plant decreased with increase in seed rate with 6 kg ha^{-1} seed rate producing the highest number of pods per plants compared with higher seed rates in 2002 and the average of the two years data. The reason for this trend could be the intra and inter-plant competition at higher seed rate for space, soil moisture, nutrients light and assimilates (Weiss, 1983; Katung, 1987; Olowe and Busari, 1994).

Broadcast method of sowing produced higher weed cover and weed dry matter in 2001 and 2002 and the average of two years data, compared to drilling although the difference in weed cover produced under the two sowing methods in 2002 was significant. This could be due to the difficulty associated with weeding in the plot with broadcast crop compared with drilled plot where weeding is easier and more effective. This result agrees with Weiss (1971) showed the superiority of row planting over broadcast to control weeds and van Rheenen (1973) who observed that the practice of seed broadcast results in over population and poses difficulties in weeding operations.

At harvest in 2001 and 2002 weed cover and total dry matter of weeds decrease with increase in seed rates up to 9 and 12 kg ha^{-1} seed rate respectively, 15 kg ha^{-1} seed rate produced the highest amount of weed dry matter and weed cover in 2001 and 2002. The highest amount of weed infestation observed at 15 kg ha^{-1} seed rate could be due to the greater difficulty of weeding. This is in line with Akobundu (1987) who observed that shading of weeds by the rapidly formed canopy of crop in narrow rows account for more efficient weed control than in widely spaced rows.

Drilling method produced higher grain yield compared with the broadcast method of sowing in 2001 and average of two years data. The reason for this could be the inter -plant competition for moisture and nutrients which could be more severe under broadcast crop compared to drilled crop during the dry spell before harvesting. Also, the higher weed infestation under the broadcast crop as evident from the higher weed cover and total dry weed weight must have further reduced the amount of nutrients and water available to the broadcast crop. This agrees with the findings of Weiss (1971) and Stonebridge (1963) who reported the superiority of row planting over broadcasting to control weeds and that this factor alone has resulted in considerable yield increases.

Grain yield increased with increase in seed rate up to 6 kg ha^{-1} and further increases in seed rate led to decline in grain yield in both years and the average of the two years data. It is only in the average of the two years data that 3 and 6 kg ha^{-1} seed rate produced significantly higher seed yield compared with higher seed rate. This trend agrees with the earlier findings by Mazzaani and Cobo (1956), Bleasdale (1966), Menon (1967), Gerakis and Tsangarakis (1971) and Delgado and Yermanos (1975) who reported yield increase with increase in plant population up to a certain level and further increase in plant population led to a decline in seed yield.

CONCLUSION

In conclusion for better method of sowing and higher yield, drilling method of sowing and 6 kg ha^{-1}, respectively are suitable for Maiduguri situated in the Sudan savanna agro-ecology of Nigeria.

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