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Growth, Yield and Phenology of Sesame (*Sesamum indicum* L.) as Affected by Sowing Method, Variety and Seed Rate in the Sudan Savanna of Nigeria.

By

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Abstract

An experiment on the effect of sowing method, variety and seed rate on the growth and phenology of sesame (*Sesamum indicum* L.) was conducted at Teaching and Research Farm of Bayero University, Kano (11058'N and 8025'E) and Dutse Jigawa State (11045'N and 9020'E), Nigeria during the 2009 rainy season. The treatments consisted of three sowing methods (Broadcasting, Dibbling and Drilling), two varieties (Ex-Sudan and E8) and four seed rates (2.5, 5.0, 7.5 and 10.0 kg ha-1). A split-split plot design was used such that sowing method was allocated to main plot, variety to the sub plot and the seed rate was assigned to the sub-sub plot and replicated three times. Results showed that at Dutse, the different sowing methods had no significant effects on plant height at 4 and 10 weeks after sowing. At Kano however, significantly taller plants were recorded with broadcasting method while drilling and dibbling remained at par with shorter plants. Broadcasting also produced plants with significantly higher number of leaves, branches and capsules at both locations. Variety E8 produced plants that are significantly taller, with more leaves and flowers and but produced the lowest yield at both locations. Variety Ex-Sudan flowered and matured earlier and also produced higher grain yield than variety E8. The different seed rates had no significant effect on number of days to flowering and maturity. But with respect to grain yield, planting 5 kg of seeds per hectare produced significantly higher grain yields at both locations, while drilling and dibbling methods produced statistically similar grain yields, although both were significantly higer than dibbling method. A linear decrease in number of leaves and capsules was observed with every increase in seed rate.

Key words: Growth, Phenology, Yield, Variety, Sowing date, Seed rate

Introduction

Sesame is ranked sixth in the world's production of oil seeds and twelfth in the world's vegetable oil production (FAO, 2010). The crop is often referred to as "queen" of vegetable oil because of its uses as condiments in houses and as ingredients in manufacture of paints, soaps, cosmetics, perfumes and insecticides (Babaji *et al*. 2005; Langhan and Wiemers, 2006). In Nigeria, sesame is an important export crop and has substantial role in the sesame trade worldwide.

The annual export of the commodity in Nigeria was valued at about 20 million U.S. dollars and Nigeria is the primary supplier of sesame seed to the world largest importer Japan, (USAID, 2009). The trend in production of sesame in Nigeria is increasing annually, considering total production of 44,000 metric tons in 1990 which rose to 69,000 metric tons in 2001 (Umar, 2005). Sesame seed production in the country was recently put at 100,000 metric tons annually (USAID, 2009). Jigawa State has been recently ranked the highest producer of Sesame in Nigeria (USAID, 2009). Sesame production started gaining prominence from 1994 (Umar, 2005) and every year more farmers embrace the cultivation of the crop because of its high value and ready market. The annual production in Jigawa state was put at 7,000 metric tons in 1994 which rose to 45, 000 metric tons in 1997 (Umar, 2005) and 102,000 metric tons in 2008 (USAID, 2009).

In Nigeria sesame production is low due to a number of constraints which include among others, poor farmers access to improved varieties, appropriate agronomic practices, drought and low soil productivity. Presently studies on sesame agronomic practices in Nigeria are mostly on plant population, fertilizer rate, sowing dates, and row spacing in the Guinea savanna zone (Malik *et al* 2003). However, research on varietal performance, sowing methods and seed rates have been scanty particularly in the Sudan savanna. In recent years, new early and extra early maturing varieties have been developed for the Sudan and Sahel agro-ecologies. However, the response of these varieties to different agronomic practices on different soils in the Sudan savannah have not been adequately evaluated in order to come up with recommendations that are based on the crop requirement, especially as it relates to fertilizer rates, planting date and planting density. There is also very little information regarding the impact of production practices on the quality of Nigerian sesame. Finding the right plant population coupled with selection of the best planting method will be an avenue to achieving higher seed yields of Sesame. This study was therefore designed and undertaken to determine the effects of sowing method, seed rate and variety on growth and phenology of sesame.

Methodology

Experimental sites

The experiment was conducted at two locations during the 2009 cropping season.Location 1 was the Teaching and Research Farm of the Faculty of Agriculture, Bayero University, Kano. This study area lies at latitude 11°58'N and longitude 8°25'E with annual rainfall of 834.5mm and mean minimum temperature range of 19.40C and a meanmaximum temperature range of

35.1^{0}C). While location 2 was Dutse in Jigawa state which lies at latitude 11045'N and longitude 9^{0}2^0'E with a mean annual rainfall of 958.5mm (JARDA, 2009). The two sites lie within the Sudan Savannah ecological zone of Nigeria.

Treatments and Experimental Design

The treatments consisted of four seed rates (2.5 kg ha-1, 5.0 kg ha-1, 7.5 kg ha-1 and 10.0 kg ha-1), three sowing methods (broadcasting, dibbling and drilling) and two varieties of sesame (Ex-Sudan and E8). The experiment was randomized and laid out in a split-split plot design with three replications. The sowing method (M) was assigned to the main plot, the variety (V) to sub-plots and the seed rate (S) allocated to the sub-sub plots. The B.U.K experiment was conducted between 10th of July 2009 and 3rd November, 2009 while the Dutse experiment was conducted between 20th of July, 2009 and 13th November, 2009.

Cultural Practices

The experimental fields were cleared, harrowed, ridged and thereafter sprayed with a pre-emergence herbicide before planting. Seeds of the two varieties were weighed using sensitive balance and four rates of 2.5, 5.0, 7.5 and 10.0 kg ha-1 were obtained. The different seed rates weight were sown using the three sowing methods according to treatment and randomization. Each plot received 60 kg N, 30 kg $P_2$05 and 30 kg $K_2$0/ha. Half dose of N and full doses of $P_2$05 and $K_2$0 were applied in form of N.P.K 15:15:15 at one week after sowing while remaining half dose of N was applied in form of urea at six weeks after sowing. Both chemical and physical weed control methods were employed to control weeds. Infestation of sesame webworm (*Antigastra catalaunalis* Dup.) was observed at both sites and was controlled using cypermethrin and dimethoate at the rate of 1 liter in 200 liters of water per hectare.

Data

Soil samples from the experimental sites were collected randomly at 0-15cm and 15-30cm using soil auger. The physical and chemical properties of the soil were determined using standard procedures. Some agro-physiological data including plant height, number of leaves, number of branches/capsules and number of days to flowering and maturity were taken. Also incidence of stresses (moisture, nutrients, pests and diseases) were collected. Meteorological data (Minimum & maximum temperatures and rainfall records) was collected from B.U.K weather station in Kano and JARDA weather station in Dutse. Data analysis was done using SAS (SAS Institute 2003). The data collected was subjected to analysis of variance (ANOVA) as prescribed by Snedechor and Cochran (1967) and means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Table 1 shows the soil properties of the two experimental sites. The soil at Kano is slightly acidic, while that of Dutse is strongly acidic. Total N, available P and organic Carbon were low at both locations, although higher values were recorded at Kano than at Dutse. Figure 1 indicates records of rainfall at both experimental sites. More rainfall was received in Kano (764mm) than at Dutse (670mm). The highest amount of rainfall was received in the month of August at both locations.

The effect of sowing method, variety, and seed rate on plant height at 4 and 10 weeks after sowing in Kano and Dutse is shown

in table 2. At Dutse, sowing method had no significant effect on plant height and number of leaves at both sampling periods except for number of leaves at 10 weeks after sowing. Broadcasting method produced the highest number of leaves, while the lowest was recorded by dibbling method. Table 3 shows the effect of sowing method, variety, and seed rate on number of days to flowering, number of days to maturity, number of branches and number of capsules per plant. At Dutse, the effect of planting method was only significant on number of capsules per plant. Broadcasting method produced the highest number of capsules, followed by dibbling method, while the least was recorded with drilling method. At Kano however, planting method had a significant effect on days to flowering, number of branches and number of capsules per plant. Plots that were planted by broadcasting and dibbling methods flowered significantly earlier than those planted by drilling. Planting by broadcasting method produced the highest number of branches and capsules, followed by drilling method, while the least was produced by dibbling method. The outcomes could not be unconnected with the fact that broadcasting method of planting is closest to optimum with respect to population. Broadcasting also limits excessive competition and thus allows the plants to flower faster and produce more branches which subsequently lead to production of more number of capsules. The findings are in line with findings made by Imoloame et al. (2007) and Olowe and Busari (1994). Weiss (1983) also reported that broadcast method of sowing produced taller plants and higher dry matter when compared with drilling and dibbling methods.

There were significant differences in height among the varieties at 4 weeks after sowing in Dutse (Table 2). Variety E8 produced significantly taller plants than variety Ex-Sudan. Similar response was observed with respect to number of leaves.

Variety E8 produced plants with significantly higher number of leaves than Ex-Sudan at all sampling periods, in both locations. Variety Ex Sudan flowered and matured significantly earlier than variety E8 at both locations (Table 3). Same variety has significantly lower number of branches and higher number of capsules per plant. The differences in plant height, number of branches and capsules, days to flowering and maturity between the two varieties could be genetic; as a similar report was made by Riaz et al. (2002) on two different sesame varieties (TS3 and 92001).

Planting at higher seed rates produced taller plants with more leaves at all sampling periods in Dutse (Table 2). The lowest seed rate (2.5 kg ha-1) produced the shortest plants with least number of leaves. Increasing the seed rate to 5 kg ha-1 led to significant increase in height and number of leaves, but subsequent increase to 7.5 kg ha-1 and 10 kg ha-1 had no further effect in Dutse. At Kano however, the influence of varying seed rates on plant height and number of leaves was only significant at 4 weeks after sowing, where the three high rates produced plants with statistically similar heights, although different from the lowest seed rate. At 10 weeks after sowing, there was no significant effect on plant height. Effect of seed rates on number of leaves was significant at 10 weeks after sowing in Kano. There was a linear decrease in number of leaves with increasing seed rates up to 7.5 kg ha-1, but further increase to 10 kg ha-1 had no

effect on number of leaves. Varying seed rates had no significant effect on number of days to flowering and maturity at both experimental locations. There was a linear decrease in number of branches and capsules with increasing seed rates at Kano. Lower seed rates produced more branches and capsules. At Dutse however, seed rates had no effect on number of branches, while linear decrease in number of capsules was observed with increasing seed rates. The increase in height that is associated with the higher seed rates could be linked to increased competition for light and space. The decrease in number of leaves, capsules and branches with increase in seed rates is unconnected with the fact that addition of plants beyond optimum population, leads to competition for growth factors which could adversely affect the plant growth. The findings are in agreement with findings of Katung (1987) who reported that when sesame plant population was increased from 100,000 to 400,000 plants per hectare, there was a corresponding increase in plant height. Umed et al. (2009) also reported that wheat sown at higher seed rate of 175kg produced greater plant height than at lower seed rates (125 and 150kg ha-1).

Planting at seed rates of 2.5 and 5kg per hectare produced significantly higher yield per per hectare at both locations. This is possibly because at low plant population there was minimal competition for space, light, moisture and nutrients which could have supported enhanced dry matter production and seed yield. Yields were drastically reduced with higher plant population, besides, the lowest yields were recorded when the sesame was planted with the highest seed rate (10kg ha-1). This could be because beyond 5kg ha-1 suffered high intra and inter plant competitions for growth resources. Thus, the superior yield at rates below 5kg ha-1 appeared to have been accounted by the high number of pods and seed yield/plant. Similar results were reported by Imoloame et al., (2007) and Umed et al. (2009).

All interactions were not significant on all measured characters at both locations except the interactions between variety and seed rate on number of capsules at Dutse. Planting variety Ex-Sudan at seed rate of 5 kg ha-1 produced the highest number of capsules per plant.

The findings of this research suggests that, planting sesame variety Ex-Sudan by broadcasting method at seed rate between 2.5 to 5.0 kg ha-1 results in better growth and establishment in the Sudan Savannah ecology. Also, variety Ex-Sudan flower and mature earlier than E8, especially if planted by broadcasting at seed rate of 5 kg ha-1. More research should be undertaken in the study area in order to conclusively recommend the best seed rates.

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Table 1: Soil Properties of Experimental Site

Property	Kano	Dutse
pH	6.2	5.5
Ca (Cmol/kg)	5.05	4.63
K (Cmol/kg)	0.66	0.57
Mg (Cmol/kg)	0.0010	0.0020
Na(Cmol/kg)	0.68	0.59
Total N(g/kg)	8.21	8.02
CEC (Cmol/kg)	8.22	7.13
OC (g/kg)	8.75	6.25
Bray1 P(mg/kg)	8.75	6.25
Clay	22	20
Silt	18	14
Sand	60	66
Texture	Loam	Loam

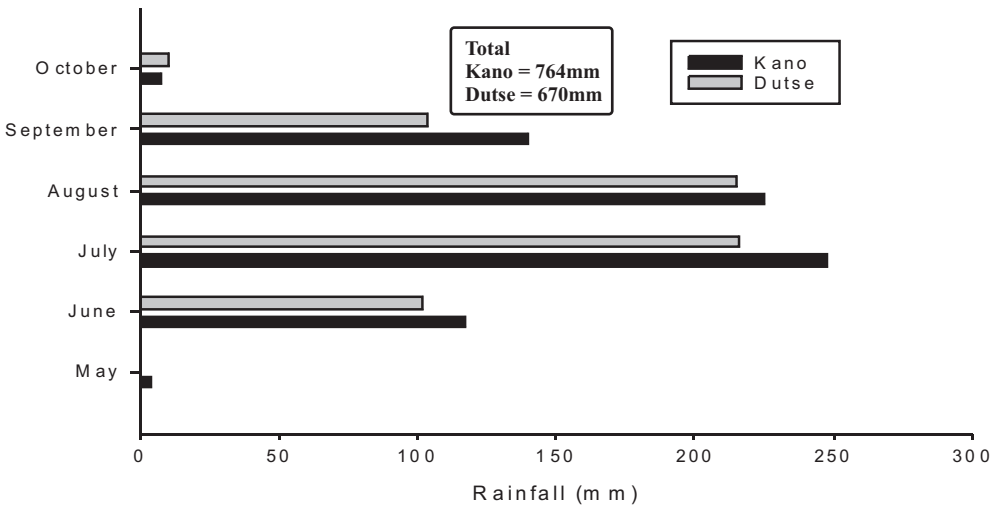

Figure 1: Record of 2009 rainfall for Kano and Dutse

Treatments	No. of days to flowering		No. of days to maturity		Number of branches per plant		Number of Capsules per plant		Grain Yield (Kg ha^{-1})	
	Dutse	Kano	Dutse	Kano	Dutse	Kano	Dutse	Kano	Dutse	Kano
Sowing Method(M)										
Broadcasting	60.0	62.5b	82.2	86.0	5.31	6.25a	83.4a	84.0a	662ab	406ab
Dibbling	61.7	62.3b	81.9	86.5	4.85	4.57c	77.0b	58.8c	602b	345b
Drilling	60.0	65.5a	81.7	86.0	4.81	5.73b	55.9c	73.5b	753a	467a
SE±	0.96	0.39	0.98	0.32	0.922	0.40	4.82	6.09	33.4	15.7
Variety (V)										
Ex-Sudan	56.1b	55.0b	75.0b	76.0b	4.51b	4.81b	71.7a	75.4a	782a	452.8a
E8	65.0a	70.0a	90.0a	96.0a	5.62a	6.23a	66.6b	68.7b	562b	358.7b
SE±	0.79	0.48	0.83	0.94	0.734	0.23	4.17	3.04	29.4	17.9
Seed rate (Kg ha-1)(S)										
2.5	60.5	62.5	82.5	86.0	5.12	6.50a	79.5a	90.4a	704a	400b
5.0	61.0	62.5	82.8	85.9	5.34	5.57b	70.1b	71.8b	732a	455a
7.5	60.8	62.8	81.9	86.5	5.24	5.03c	66.5c	67.0c	651ab	401b
10.0	60.7	63.0	82.2	86.0	4.96	4.27d	62.3d	61.1d	602b	361c
SE±	0.93	1.96	1.02	0.78	0.928	0.26	4.86	5.32	33.3	11.57
Interaction										
M x V	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	NS	NS	**	NS	NS	NS
M x V x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same or no letter (s) within a column are not significantly different at 5% level of probability using DMRT. NS = Not significant, ** = Significant at 1%

Table 3: Effect of Sowing method, variety, and seed rate on number of days to flowering number of days to maturity, number of branches per plant, number of capsules per plant, and grain yield at Dutse and Kano, 2009.

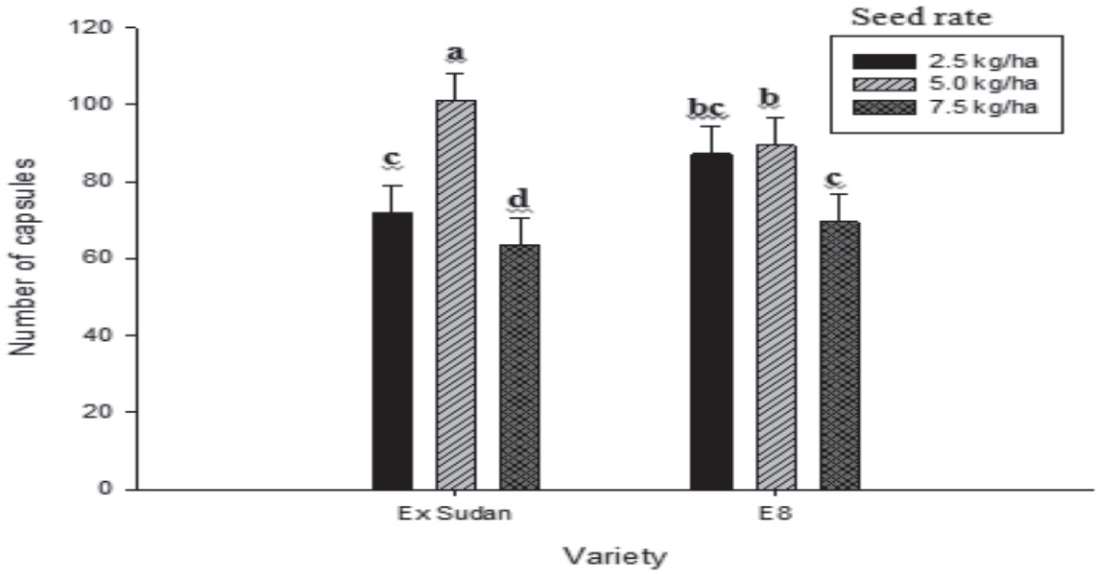

Figure 3: Interaction of Variety and Seed rate of Sesame on Number of Capsules per plant at Dutse