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Response of sesame to nitrogen and phosphorus fertilization in Northern Sudan

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ABSTRACT

Objective: Crop rotation in Northern Sudan is unpaired and farmers put more emphasis on the winter crops with limited agricultural activities during the summer season. Sesame (*Sesamum indicum L.*) was introduced recently as an irrigated summer crop that could fill this gap. This study investigated the response of sesame variety Shuak to nitrogen and phosphorus fertilizer application.

Methodology and results: Field experiments were conducted during 2004/05 seasons in the Experimental Farm of the Faculty of Agriculture, Nile Valley University, at Darmali, Northern Sudan. The experiment was laid out in split plot design with four replications. The treatments consisted of three levels of phosphorus (0, 22 and 44 Kg P_2O_5 ha^{-1}) assigned to the main-plots and five levels of nitrogen (0, 22, 44, 66 and 88 Kg N ha^{-1}) assigned to the subplots. Parameters recorded included number of plants m^{-2}, plant height, height above ground to first capsule, number of leaves per plant, number of branches per plant, number of capsules per plant, 1000-seed weight and seed yield per unit area. Nitrogen had a significant effect on the number of plants per square meter, number of branches, number of capsules per plant and seed yield per unit area. The highest and least seed yields were produced in plots treated with 44 and 0 kg N ha^{-1}, respectively. Phosphorus had no significant influence on the studied traits, but interaction between P and N fertilizers influenced some of the attributes.

Conclusion and application of findings: Application of 44 kg N ha^{-1} resulted in a marked increase in seed yield and yield components of sesame variety Shuak under conditions of Northern Sudan. These finding demonstrate that sesame can be included into the rotation cycle during the summer season and that the productivity of the crop can be significantly increased by application of fertilizers.

Key words: *Sesamum indicum L.*, nitrogen, phosphorus, seed yield.

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INTRODUCTION

In the Sudan, sesame (*Sesamum indicum* L.) is one of the important oil crops, coming third in production area after sorghum and millet. It draws its importance from its use as a food crop, a raw material for industry, feed for livestock and as a leading export crop. Sudan ranks second in the volume of sesame exports and accounts for 80% and 40% of all cultivated sesame area in the Arab world and African continent, respectively (Abdalla & Abdel Nour, 2001).

The effect of fertilizer application, mainly nitrogen, phosphorus and potassium on sesame yield was previously investigated under rainfed and supplementary irrigation (Salih, 1962; Ageeb, 1969) with results indicating no real trend. It is particularly difficult to compare the plant's performance on fertile and infertile soils in any given area (Kumar & Ahlawat, 1986). In Egypt, application of clay and straw plus nitrogen substantially increased the seed yield of crops including sesame (Nafady & Khader, 1975). Mujaya and Yerokum (2003) concluded that using more than 30 kg N ha^{-1} on sesame was not attractive because the increments in yield above this rate become smaller.

In Sudan, Osman (1986) concluded that application of nitrogen or phosphorous had no significant effect on all sesame parameters. However, at Kazgail, application of phosphorous significantly increased the number of capsules per plant. Adam (1986) found that application of nitrogen increased number of capsules, plant height and seed yield but there was no significant response when phosphorus was applied. On the other hand Kafiriti and Deckers (2001) indicated that application of 20-30 kg N ha^{-1} and equal amounts of phosphorous increased the chance of getting an economic return, especially on poor soil.

The amount of soil moisture available, either natural or by irrigation influences nutrient uptake by plants. Ghosh and Patra (1994) found that sesame seed yield increased with up to 1420 kg/ha when supplied with 96 kg N, 18 kg P_2O_5 and 52 kg K_2O ha $^{-1}$. Wesis (1983) reported that in the presence of adequate phosphate, 20kg N/ha would be adequate, and it is unlikely that more than 50kg ha^{-1} would be profitable except on high-yielding, irrigated crops. Sinharoy *et al*., (1990) concluded that application of 30 and 60 kg N ha^{-1} increased sesame plant height, number of primary branches per plant and seed per capsule, resulting in average yields of 651 and 801 kg ha^{-1}, and a 1000 seed weight of 2.8 and 2.9 g, respectively, compared to 358 kg ha^{-1} and 2.8 g without nitrogen. In Brazil, application of fertilizer increased yield by 58.7% with 30 kg of nitrogen and an increase of 62.6% with the higher rate of phosphorous (Beltrao *et al*., 1989). Ashfaq *et al.* (2001) found that the highest seed yield and yield components were obtained with 20 and 40 kg ha^{-1} nitrogen and phosphorous rates, respectively.

Crop rotation in Northern Sudan is unpaired and farmers put more emphasis on the winter crops with limited agricultural activities during the summer season. Sesame was introduced recently as an irrigated summer crop that could fill this gap. The objective of this investigation was to study the response of sesame to nitrogen and phosphorus fertilizer application.

MATERIALS AND METHODS

Field experiments were conducted during 2004 - 2005 seasons in the Experimental Farm of the Faculty of Agriculture, Nile Valley University at Darmali, Northern Sudan (17°48' N; 34°00' E; altitude 346.5 meters above sea level). The soil at the experimental plots is of calcareous matrix, strongly alkaline with low permeability to water and low in nitrogen and humus content (El Mahdi, 2003)

The experiment was laid out in split plot design with four replications. The treatments consisted of three levels of phosphorus (0, 22 and 44 Kg P_2O_5 ha^{-1}) assigned to the main-plots and five levels of nitrogen (0, 22, 44, 66 and 88 Kg N ha^{-1}) assigned to the subplots. The land was prepared by disc plough and disc harrow, leveled and ridged. Sesame cultivar Shuak was sown on the 1st of July 2004 in the first season and on 7th July 2005 in the second season, and irrigated every 7 days. The plot size was 3.5 ×6 m^2, with six ridges spaced 70 cm between. Urea (46% N) was applied in split dose as a source of nitrogen, half-dose applied at sowing and the rest four weeks after sowing. Triple super phosphate (48% P_2O_5) was applied as a source of phosphorous before sowing. The plants were thinned to specified plant density (25 m^{-2}) and the crop was kept clean by hand weeding two and three weeks after sowing, respectively.

Data were observed on ten plants randomly selected from the harvest area. Parameters assessed included height above ground to first capsule, plant height (soil surface to tip of growing point), number of plants m^{-2}, number of leaves, branches, capsules and seed yield per plant. Seed yield per unit area was obtained from the three center rows of each plot leaving 1 m from both ends of the plots as margins. Plants were harvested manually by cutting at the soil surface, bound and air dried for twenty days before threshing and measuring seed yield per unit area and the 1000-seed weight.

Analysis of variance was used to test the significance of treatment effects. Least Significant Difference Test was used to compare treatment means using the computer program MSTAT-C (MSTAT-C, 1991).

RESULTS

Considering plant growth the sesame crop responded positively to nitrogen fertilization, but the number of plants per unit area was not significantly affected (Table 1). A comparison of simple interactive effects showed that the tallest plants (mean 87 cm) were produced with the application of 88 Kg N $ha^{-1}$and 44 kg P_2O_5 ha^{-1} while the shortest plants (mean 64cm) were obtained where none of the fertilizers was applied.

Height to first capsule was affected by levels of nitrogen and phosphorus with significant interaction between the fertilizers (Table 2) but the number of leaves per plant did not vary significantly with fertilizer levels. Application of fertilizers also significantly affected the number of branches per plant as well as the number of capsules (Table 3). Both parameters generally increased as the amount of fertilizer applied increased.

The 1000-seed weight varied but was not significantly affected by fertilizer application (Table 4). However, seed yield was significantly affected by the interactive effects of N and P application. The highest seed yield (919 kg ha^{-1}) was obtained by application of 44 N Kg N ha^{-1}- and 44 kg P_2O_5 ha^{-1}. Increasing the amount of N from 0 to 44 kg ha^{-1} caused substantial increases in yield but amounts above 44 kg/ha appeared to have a negative effect, resulting in reduced yields. The higher yields were associated with more plants per unit area as well as more branches and number of capsules per plant.

Table 1: Effect of nitrogen and phosphorous application on number of plants and plant height (cm) of sesame in Northern Sudan.

Nitrogen	Number of plant m^{-2}			Plant height (cm.)		
	Phosphorus levels (kg/ha)			Phosphorus levels (kg/ha)		
	0	22	44	0	22	44
0	12.0	13.0	12.7	64.0	70.7	64.0
22	18.0	14.3	16,0	69.7	73.3	66.0
44	13.0	21.7	15.0	68.0	80.0	79.0
66	9.3	18.0	12.0	72.7	81.0	81.3
88	9.7	13.0	12,7	79.7	80.7	87.0
LSD 0.05	4.62			15.64		

Table 2: Effect of nitrogen and phosphorous application on height of first capsule and number of leaves per plant of sesame crop in Northern Sudan.

Nitrogen	Height of first capsule (cm)			No. of leaves $plant^{-1}$		
	Phosphorus levels (kg/ha)			Phosphorus levels (kg/ha)		
	0	22	44	0	22	44
0	39.0	36.3	34.3	15.0	18.3	15.0
22	45.3	41.3	39.7	16.7	17.0	18.7
44	41.0	48.3	46.7	17.7	16.3	22.3
66	48.0	42.3	41.0	19.3	15.7	18.0
88	34.7	41.3	34.7	17.7	18.0	16.3
LSD 0.05	10.42			3.89		

DISCUSSION

In the present study, the response of sesame to nitrogen and phosphorus fertilizers was evaluated under agroecological conditions in Northern Sudan. Results showed that, plant height and height to first capsule were significantly affected by nitrogen and phosphorus application, which agrees with the findings of Adam (1986) and Osman (1986). The number of leaves per plant did not vary significantly with the application of nitrogen and phosphorus, thus contradicting with the results obtained by Subrahmaniyan and Arulmozhi (1998). The number of capsules per plant increased with increasing nitrogen levels, which might be attributed to the role of nitrogen in stimulating vegetative growth as noted by Adam (1986) and Ashfaq *et al*. (2001).

The 1000 seed weight was not significantly affected by nitrogen application, confirming the findings of Sinharoy *et al*. (1990). The increased seed yield caused by application of nitrogen could be due to enhanced vegetative growth and other yield attributes, e.g. more branches and capsules per plant.

The highest seed yield was obtained by the application of 44 N Kg N ha^{-1}- and 44 kg P_2O_5 ha^{-1}. These would therefore be the ideal fertilizer application rates for sesame production under conditions of Northern Sudan. Furthermore, these findings agree with those of Adam (1986), Ghosh and Patra (1994), Kafiriti and Deckers (2001) and Mujaya and Yerokum (2003). The study demonstrated that sesame can be included into the rotation cycle during the summer season in Northern Sudan and that the productivity of the crop can be significantly increased by application of fertilizers.

Table 3: Effect of nitrogen and phosphorous application on number of branches and number of capsules per plant of sesame crop in Northern Sudan.

Nitrogen	Number of branches plant $^{-1}$			Number of capsules plant^{-1}		
	Phosphorus levels (kg/ha)			Phosphorus levels (kg/ha)		
	0	22	44	0	22	44
0	1.6	1.4	2.3	31.7	26.0	19.6
22	2.4	2.2	2.6	20.7	28.3	36.3
44	1.7	3.0	2.6	33.7	28.3	36.0
66	2.1	2.2	2.9	27.3	38.7	42.3
88	2.3	3.5	2.9	30.0	54.0	47.7
LSD 0.05	0.86			9.12		

Table 4: Effect of nitrogen and phosphorous application on the 1000-seed weight and seed yield of sesame crop in Northern Sudan.

Nitrogen	1000-seed weight			Seed yield (kg ha^{-1})		
	Phosphorus levels (kg/ha)			Phosphorus levels (kg/ha)		
	0	22	44	0	22	44
0	2.3	2.3	2.4	258	206	199
22	2.3	2.5	2.4	429	605	566
44	2.6	2.5	2.6	769	581	919
66	2.5	2.6	2.5	481	592	678
88	2.5	2.6	2.5	286	831	529
LSD 0.05	0.38			434		

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