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Physiological parameters, yield attributes and nutrient uptake in sesame (*Sesamum indicum* L.) as influenced by different doses of nitrogen and potassium fertilizer under semi-arid eastern plains zone of Rajasthan

Anju Bijarnia, OP Sharma and Ramesh Choudhary

Abstract
A field experiment was conducted at Agronomy farm, S.K.N. College of Agriculture, Jobner in Jaipur district of Rajasthan during *kharif* season of 2016 on loamy sand soil. The experiment consisted of four levels each of N (0, 20, 40 and 60 kg/ha) and potassium (0, 10, 20 and 30 kg K_2O/ha). The total 16 treatment combinations were tested in randomized block design with three replication. Results indicated that progressive increase in level of nitrogen up to 40 kg/ha significantly increased physiological parameters (leaf area index & chlorophyll content), yield attributes (number of capsules/plant, seeds/capsule and test weight) and total nutrient uptake (N, P & K) in sesame. Further increase in nitrogen level to 60 kg/ha could not enhance the above parameters significantly. Results further revealed that progressive increase in level of potassium up to 20 kg/ha significantly increased above mentioned parameters of sesame over 10 kg K_2O/ha and control. The above treatment remained at par with 30 kg K_2O/ha.

Keywords: Nitrogen, nitrogen uptake, physiological parameters, potassium, yield attributes

Introduction
Sesame (*Sesamum indicum* L.) comes from the family pedaliaceae and the genus *sesamum*. In India sesame is an edible oilseed crop next to groundnut and rapeseed-mustard. Its oil content generally varies from 46 to 52 per cent and protein content from 18-20 per cent. Sesame protein is very important as a protein source for human consumption due to presence of the balanced amino acid composition, especially sulphur containing amino acid methionine, which is very rare in other plant protein.

Sesame is extensively cultivated in the states of Gujarat, West Bengal, Tamil Nadu, Maharashtra, Karnataka, Rajasthan and Madhya Pradesh. Gujarat alone accounts for 20 per cent of the national production. Despite of being such an important sesame growing country, in India the average productivity is very low in comparison to global as well as national level. Cultivation of crop on marginal and sub-marginal lands of poor fertility under rainfed condition, low and scanty rainfall, poor agronomic practices and inadequate or even no use of fertilizers are the major factors responsible for low productivity of the crop.

Poor nourishment especially of nitrogen, is the factor of low productivity of sesame. Nitrogen is university deficient plant nutrient in most of the Indian soils, particularly the light textured ones where most of sesame growing areas are confined (Chhonkar and Rattan, 2000) [3]. Besides nitrogen, potassium is an essential macro nutrient that is taken up by plants from soil in relatively large amounts. Potassium plays a key role in many metabolic processes in plants. It is essential for photosynthesis, activates more than 60 enzymatic systems, promotes translocation and storage of assimilates, synthesis of proteins, controls tissue water balance for more efficient water use and favours a high energy status in the plants. In spite of the enormous role of potassium in plant physiological and metabolic processes as well as activation of many enzymatic systems, its application to field crops is being ignored with the understanding that our soils are not deficient in potassium. Considering the above facts in view, the present investigation was conducted during *kharif*, 2016.

Material and Methods
A field experiment was conducted during the *kharif* season of 2016 at SKN College of Agriculture, Sri Karan Narendra Agricultural University, Jobner.

The average annual rainfall of this tract varies from 400 mm to 500 mm and is mostly received during the months of July to September. The average annual rainfall of the tract is mostly received during the rainy season. Soils are loamy sand with 0.21% organic carbon, 126.3 kg/ha N, 19.23 kg/ha P_2O_5 and 150.26 kg/ha K_2O. Experiment was laid out in a radnomized plot design with three replications comprising 16 treatment combination. The recommended dose of 25 kg P_2O_5 per ha through SSP was drilled as basal 10 cm deep and N and K_2O were applied as per treatment through urea and MOP, respectively. The dose of sulphur @ 20 kg/ha was applied through sulphur dust. Sesame cultivar 'RT- 346' was sown with standard package of practices. Three irrigation applied to the crop. All the plant protection measures were adopted to take healthy crop at maturity stage, after leaving two rows on each side as well as 50 cm along the width of each side, a net plot area was harvested separately for recording the yield attributes and yields. The harvested material was tied and tagged and kept on threshing floor sun drying. Different yield attributes *viz*., capsules/plant, seeds/capsule were reported at physiological maturity of the sesame.

Leaf area index (LAI)

Five plants were randomly selected for leaf area at 30, 60 DAS and harvest. The leaf area was measured with the help of portable leaf area meter at the experimental site. LAI was calculated by the following relationship (Watson, 1958) [13].

$$\text{Leaf area index} = \frac{\text{Leaf area (cm}^2\text{)}}{\text{Ground area (cm}^2\text{)}}$$

Chlorophyll content

Total chlorophyll content of leaves at 60 DAS was determined using the method advocated by Arnon (1949) [1] by taking 50 mg fresh leaf material. Samples were homogenized in 80% acetone and centrifuged for 10 minutes at 2000 rpm and volume of supernatant was made to 10 ml. The resultant absorbence of clear supernatant was measured by spectrophotometer at 652 nm.

$$\text{Total chlorophyll (mg/g)} = \frac{A_{(652)} \text{ x } 29 \text{ x total volume (ml)}}{\alpha \text{ x } 1000 \text{ x weight of sample (g)}}$$

Nutrient uptake

The nutrient uptake by crop was calculated by multiplying the per cent N and P content in seed and straw with their respective dry matter and expressed as kg/ha.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Per cent nutrient in seed x seed yield (kg/ha)} + \text{Per cent nutrient in stalk x stalk yield (kg/ha)}}{100}$$

Result and Discussion

Effect of Nitrogen

Application of successive nitrogen up to 40 kg/ha significantly increased the yield attributes *viz*., number of capsules/plant, seeds/capsule and yield (seed & stalk). Data presented in table 1 showed that the increasing levels of N upto the maximum dose i.e. 60 kg/ha brought linear increase in test weight of sesame. The overall improvement in vigour and crop growth as explained in preceding paragraphs due to adequate supply of nitrogen early in the life of a plant is considered important in promoting rapid vegetative growth and biomass. Increasing growth in terms of plant height, dry matter accumulation and branches provided sufficient sites for number of capsules/plant and seeds/capsule. These result are in close conformity with Sarala and Jagannatham (2002) [8] in sesame.

All the physiological parameters *viz*., leaf area index and chlorophyll content increased linearly with the corresponding increase in levels of N. This increment was, by and large, statistically significant over control and 20 kg N/ha and found at par with 60 kg N/ha. The biological role of nitrogen as an essential constituent of chlorophyll in harvesting solar energy, phosphorylated compounds in energy transformations, nucleic acids in the transfer of genetic information and the regulation of cellular metabolism protein as structural units and biological catalysts are well known. These results obtained in present investigation are in close conformity with the results of Deshmukh *et al.* (2008), Mona and Ajab (2017).

Increasing levels of N significantly increased total N, P and K uptake by sesame. Higher N, P and K uptake might be due to improved nutritional environment in the rhizosphere as well as in the plant system leading to enhanced translocation of N, P and K in plant parts. Since the nutrient uptake is a function of its content in crop plant and seed and stalk yield of the crop. The increase in these parameters due to N led to an increased uptake of nutrients in the present study. Another reason for higher nitrogen content might be due to increased activity of nitrate reductase enzyme. These results are in close conformity with the findings of Mondal *et al*. (2001) [7], Sujathamma *et al*. (2003) [11] and Shehu *et al*. (2010) [10] in sesame.

Effect of potassium

Yield attributing characters and yield of sesame were significantly improved by potassium fertilization. Application of potassium at 20 kg/ha (Table 1) recorded 41.71 capsules/plant, 39.17 seeds/capsule that were significantly higher than 10 kg/ha and control. Further increase in level of potassium to 30 kg/ha, though, attained the highest values of all yield determining characters, but variation was not significant from 20 kg K_2O/ha. Further potassium application at 20 and 30 kg/ha significantly improved the test weight of seeds over control. The favourable effect of K fertilization on yield attributes might be due to the fact that potassium is well known for its role as 'enzyme activation' in various metabolic processes. The results are in agreement with those of Sarkar and Pal (2005) [9], Jadav *et al.* (2010) [5] on sesame.

It is clear from data (Table 1) that increase in the potassium level from 0 to 10 kg/ha significantly increased the leaf area index over lower level. Further increase in level of potassium upto 30 kg/ha, though, recorded the linear increase in leaf area but variation was not significant from the preceding level. It can be assigned to the overall improvement in vigour and crop growth as reflected in leaf area index. Data also indicated that there are no significant effect of potassium on chlorophyll content. The result of this study were in close conformity as observed by Sarkar and Pal (2005) [9] in sesame.

Increasing in the level potassium upto 20 kg/ha significantly increase the total N, P and K uptake in seed and stalk of sesame, however this level was remained at par with 30 kg/ha. The increase in nitrogen uptake in seed and stalk might be due to cumulative effect of increased seed and stalk yields as well as favourable effect on availability of nitrogen at the higher

level of phosphors & potassium. Increase in uptake of the nitrogen & phosphorus with potassium application might be due to increase in seed and stalk yield of sesame (Jadav *et al.*, 2010) [5]. Brar *et al.* (2010) [2] and Vaghani *et al.* (2010) [12] also reported that the uptake of N, P and K in seed and stalk were significantly increased with increasing levels of potassium.

Table 1: Effect of nitrogen and potassium on yield attributes, yield, physiological parameters and nutrient uptake in sesame

Treatments										
	Yield attributes			Yield (Kg/ha)		Physiological parameters		Nutrient uptake (Kg/ha)		
	No of capsules/ plant	No of seeds/ capsule	Test weight (g)	Seed yield	Stalk yield	LAI	Chlorophyll content (mg/g)	N	P	K
Nitrogen (N kg/ha)										
0	33.40	30.96	2.48	642	1812	3.21	1.21	38.8	7.6	13.6
20	39.67	36.95	2.59	881	2470	3.80	1.29	58.3	10.7	19.3
40	42.63	40.20	2.67	983	2821	4.13	1.38	70.1	12.2	22.3
60	43.66	41.28	2.70	1020	2893	4.22	1.43	73.0	12.8	23.1
S.Em±	0.92	0.92	0.05	24	65	0.09	0.02	1.6	0.3	0.5
CD	2.64	2.66	0.15	69	186	0.26	0.07	4.5	1.0	1.6
Potassium (K_2O kg/ha)										
0	35.75	33.68	2.49	711	2009	3.47	1.29	47.0	8.6	14.5
10	38.84	36.45	2.59	877	2477	3.77	1.31	58.9	10.7	18.6
20	41.71	39.17	2.66	958	2727	4.00	1.33	66.2	11.8	22.1
30	43.06	40.09	2.70	980	2783	4.12	1.36	68.0	12.3	23.1
S.Em±	0.92	0.92	0.05	24	65	0.09	0.02	1.6	0.3	0.5
CD	2.64	2.66	0.15	69	186	0.26	NS	4.5	1.0	1.6

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