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Response of sesame (*Sasamum indicum* L.) to nitrogen and potassium fertilization

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Abstract
A field experiment was conducted at department of agronomy, School of Agricultural Sciences, G. H. Raisoni University, Saikheda, Chhindwara Madhya Pradesh during *Rabi* season 2018. The experiment consisted of 16 treatment combinations of four levels each of potassium (0, 25, 50 and 75 kg ha^{-1}) and Nitrogen (0, 20, 40 and 60 kg ha^{-1}). The experimental results revealed that maximum seed yield (1519.58 kg ha^{-1}), net returns (□ 58350 ha^{-1}) and B:C ratio (3.9) were recorded under the application of progressive increase in level of potassium up to 40 kg K_2O ha^{-1} and Nitrogen 20 kg ha^{-1} over rest of treatments.

Keywords: Nitrogen, potassium fertilization and agricultural sciences

Introduction
Sesame (*Sesamum indicum* L.) is main oilseed crop in India and sub-continent followed by groundnut and rapeseed. Sesame is considered as the oldest oil yielding plant famous to human being. Sesame is called as 'the queen of oils' because of extra being a short duration crop, fit well into various cropping sequences/systems. Globally, sesame is grown on 6.57 million hectares with production of 2.94 million tonnes with productivity of 448 kg ha^{-1}. In India, it is cultivated on 17 lakh hectares and the total production of 7.48 lakh tones with productivity of 439 kg ha^{-1} (Anonymous, 2013) [1]. Nitrogen is one of the basic plant nutrients and plays role in various physiological processes of plants and acts as the constituent of compounds like amino acid, proteins, nucleic acids, porphyrin, flavin, purine, pyrimidine, nucleotides, enzyme and co-enzyme and adequate supply of nitrogen is associated with vigorous vegetative growth and deep green colour of plants. Nitrogen is also an integral part of chlorophyll. Thus, there is an urgent need to refine fertilizer requirement especially of N for sustained higher yield as well as superior quality product. Potassium plays an important role in activation of enzymes and resistance to cold, disease, water stress and other adverse conditions. Keeping this in view, the investigation was carried out to study the effect of potassium and sulphur on growth, yield attributes and yield of sesame crop.

Materials and methods
The experiment was conducted at Department of Agronomy, School of Agricultural Sciences, G H. Raisoni University, Saikheda, Chhindwara Madhya Pradesh in Factorial Randomized Block Design with three replication using sesame cv. AKT-101. There were 16 treatments consisting of four levels of N (0, 20, 40 and 60 kg N ha^{-1} applied as Urea) and four levels of K (0, 10, 20 and 30 kg K ha^{-1} applied as Muriat of potash). Soil of the experimental was loamy sand in texture. The soil was low in organic carbon (0.21%), low available nitrogen (126.3 kg N ha^{-1}), medium in available phosphorus (19.23 kg P_2O_5 ha^{-1}) and in available potassium (150.26 kg K_2O ha-1) and soil was non saline with a reaction 8.3.

Result
Plant height
Nitrogen: A critical examination of data (Table 1) revealed that nitrogen levels differed significantly in plant height at all the stages. Application of nitrogen upto 40 kg ha^{-1} recorded the significantly tallest plants at 30 DAS (62.08 cm), 60 DAS (225.43 cm) and at harvest (273.78 cm) over 20 kg N ha^{-1} and control.

Potassium: A perusal of data presented in table 1 revealed that all the levels of potassium significantly improved the plant height of sesame over control. At all stages of crop growth, except 30 DAS increasing levels of potassium fertilization significantly increased the plant height upto 20 kg ha^{-1} over preceding levels.

Table 1: Effect of nitrogen and potassium on plant height at different stages

Treatment	Plant height (cm)		
	30 DAS	60 DAS	At harvest
Nitrogen (N kg ha^{-1})			
0	42.82	150.13	182.68
20	40.85	148.17	180.42
40	62.08	225.43	273.78
60	43.02	150.34	182.72
SE(D)	4.80	13.68	16.53
CD(P=0.05)	9.81	27.94	33.76
Potassium (K_2O kg ha^{-1})			
0	46.00	164.20	199.86
10	47.21	167.61	203.96
20	47.55	170.75	207.71
30	48.01	171.51	208.06
SE(D)	4.80	13.68	16.53
CD(P=0.05)	9.81	27.94	33.76

Nitrogen: Data presented in table 2 revealed that number of branches of sesame was significantly influenced due to nitrogen, wherein N at 40 kg ha^{-1} produced significantly higher number of branches at 60 DAS (6.30) at harvest (7.44) over 20 kg N ha^{-1} and control, respectively and it was at par with 60 kg N ha^{-1}.

Potassium: It is apparent from data presented in table 2 that progressive increase in level of potassium upto 20 kg ha^{-1} produced significantly more number of branches plant^{-1} at 60DAS (4.84) and at harvest (5.03) over preceding levels.

Table 2: Effect of nitrogen and potassium on number of branches per plant

Treatment	Number of branches plant^{-1}	
	60 DAS	At harvest
Nitrogen (N kg/ha)		
0	4.25	4.72
20	4.18	4.63
40	6.30	7.44
60	4.29	4.75
SE(D)	0.4117	0.6245
CD (P=0.05)	0.841	1.275
Potassium (K_2O kg/ha)		
0	4.61	4.79
10	4.71	4.90
20	4.84	5.03
30	4.86	6.82
SE(D)	0.4117	0.6245
CD (P=0.05)	0.841	1.275

Dry matter accumulation per plant

Nitrogen: Dry matter accumulation in general increased with the advancement of crop stage. Data (Table 3) indicated that there was significant difference among the nitrogen levels with respect to their ability to accumulate dry matter at all the stages. Application of nitrogen upto 40 kg ha^{-1} produced the significantly higher dry matter at 30DAS (12.42), 60 DAS (30.01) and at harvest (30.92) over control.

Potassium: A critical examination of data (Table 3) revealed that successive addition in level of potassium from 20 kg ha^{-1} significantly increased the crop dry matter accumulation at all stages except at 30 DAS over lower levels. The level of potassium at 30 kg ha^{-1} registered dry matter production of 7.30 g plant^{-1} and 20.86 g plant^{-1} and 21.58g plant^{-1} at 30 DAS and 60 DAS and harvest stages, respectively.

Uptake of nutrients in general and N in particular seemed to have promoted vegetative growth in terms of plant height and dry matter production probably by promoting greater meristematic activity. This increased leaf area index as a result of N fertilization seemed to have resulted in better interception, absorption and utilization of radiant energy with greater CO_2 fixation and thereby increased the photosynthetic efficiency appreciably. Results of the present investigation are inconformity with those of Lone *et al.* (2009) [5] and Ogundare *et al.* (2015) [6].

The increase in plant height could be attributed due to the beneficial effect of potassium fertilization on growth (Brar *et al.* 2010) [2] and augment of cell division and cell expansion. Such increase may be due to the sufficient availability of potassium in soil plant root system and the increased availability of potassium to plants leading to greater photosynthesis and enhancement of metabolic and enzymatic activities in the plant. The result of this study were in close conformity as observed by Sarkar and Pal (2005) [7], Thanunathan *et al.* (2006) [8] and Deshmukh *et al.* (2010) [3] on sesame.

Table 3: Effect of nitrogen and potassium on dry matter accumulation per plant

Treatment	Dry matter accumulation(g)		
	30DAS	60 DAS	At harvest
Nitrogen (N kg/ha)			
0	5.16	16.81	17.40
20	5.20	17.09	17.68
40	12.42	30.01	30.92
60	5.21	17.18	17.81
SE(D)	1.18	2.31	2.36
CD(P=0.05)	2.42	4.73	4.83
Potassium (K_2O kg/ha)			
0	6.51	19.34	19.97
10	6.89	20.06	20.73
20	7.28	20.83	21.53
30	7.30	20.86	21.58
SE(D)	1.1868	2.3184	2.3693
CD (P=0.05)	2.424	4.735	4.839

Number of capsules plant^{-1}

Nitrogen: A perusal of data (Table 4.6) revealed that there was significant difference among nitrogen levels with respect to number of capsules per plant. The application of nitrogen upto 40 kg ha^{-1} recorded the significantly maximum number of capsules per plant (71.23) over preceding levels but remained at par with 60 kg N ha^{-1}.

Potassium: A perusal of data (Table 4) further indicated that every increase in level of potassium from 0 to 20 kg ha^{-1} significantly enhanced the number of capsules/plant over preceding level. It recorded (54.89) capsules plant^{-1} over 10 kg ha^{-1} and control, respectively. Although, application of potassium at 30 kg ha^{-1} maximized the number of capsules plant^{-1} (55.56).

Number of seeds capsule^{-1}

Nitrogen: Data (Table 4) indicated that the N application upto 40 kg ha^{-1} produced significantly higher number of seeds per capsule (71.18) over its preceding levels and was at par with 60 kg N ha^{-1}.

Potassium: A reference of data (Table 4) showed that application of potassium at 20 and 30 kg ha^{-1} recorded (56.08) and (56.53) seeds capsule^{-1} in sesame that were found significantly higher over 10 kg ha^{-1} and control.

Test weight

Nitrogen: Data (Table 4) showed that the increasing levels of N upto the maximum dose *i.e.* 60 kg ha^{-1} at (3.43 g) brought linear increase in test weight of sesame. However, significant variation was not observed between successive levels of N. Hence the N application at higher rates i.e. 40 and 60 kg ha^{-1} could enhance the test weight significantly by 7.66 and 8.70 per cent over control, respectively.

Potassium: It is also evident from data pertaining to test weight (Table 4) that response of applied potassium was almost similar to that of N, wherein the significant increase over control was recorded at higher rates. Hence, potassium application at 20 and 30 kg ha^{-1} improved the test weight of seeds by 6.83 and 8.43 per cent, respectively over control.

Table 4: Effect of nitrogen and potassium on yield attributes

Treatment	Yield attributes		
	No. of Capsules plant^{-1}	No. of Seeds capsule^{-1}	Test weight (g)
Nitrogen (N kg/ha)			
0	47.43	49.13	3.40
20	48.41	50.02	3.42
40	71.23	71.18	5.11
60	48.75	50.34	3.43
SE (D)	5.04	4.78	0.29
CD(P=0.05)	10.31	9.77	0.60
Potassium (K_2O kg/ha)			
0	51.91	53.33	3.78
10	53.46	54.72	3.83
20	54.89	56.08	3.86
30	55.56	56.53	3.88
SE (D)	5.0484	4.7859	0.2974
CD(P=0.05)	10.310	9.774	0.607

Seed yield

Nitrogen: An appraisal of data (Table 5) clearly indicated that application of 40 kg N ha^{-1} was found to be significantly superior to control and 20 kg N/ha giving 1519.58 and 1045.25 kg ha^{-1} higher seed yield, respectively. The corresponding increase in terms of percentage was 53.12 and 11.58. Further increase in level of N to 60 kg ha^{-1} could not improve the seed yield of sesame significantly. Hence, 40 kg N ha^{-1} was the most effective dose.

Potassium: It is apparent from data presented in (table 5) that seed yield of sesame increased significantly with successive increase in level of potassium upto 20 kg ha^{-1}. This level of potassium fertilization produced the seed yield of 1197.25 kg ha^{-1}, over 10 kg ha^{-1} and control, respectively.

Stalk yield

Nitrogen: An appraisal of data in table 4.7 showed that nitrogen levels differed conspicuously among themselves in stalk yield. Fertilizing the crop with 40 kg N/ha recorded the stalk yield of 4307 kg ha^{-1} which was significantly higher over control (2861 kg ha^{-1}) and 20 kg N ha^{-1} (2977.67 kg ha^{-1}).

Potassium: Results showed that different levels of potassium also led significant impact on stalk yield of sesame (Table 5). Significant response to applied potassium in terms of stalk yield was observed upto 20 kg/ha (3400.50 kg ha^{-1}), whereas, the maximum stalk yield of 3428.83 kg ha^{-1} was recorded at 30 kg ha^{-1}.

Biological yield

Nitrogen: A reference to data (Table 5) indicated that 40 kg N ha^{-1} produced the biological yield of 5808.83 kg ha^{-1} which was significantly higher over control and 20 kg N ha^{-1}.

Potassium: A perusal of data (Table 5) pertaining to the effect of potassium levels on biological yield of sesame revealed that every addition in level of potassium incurred significant enhancement in biological yield upto 20 kg ha^{-1} over preceding level. It increased the biological by a huge margin of 300 and 877 kg ha^{-1} and per cent increase of 9.00 and 31.86 over 10 kg ha^{-1} and control, respectively.

Harvest index

Data presented in table 5 showed that the harvest index remained statistically unchanged due to varying levels of nitrogen and potassium.

Table 5: Effect of nitrogen and potassium on yields and harvest index

Treatment	Yield attributes			
	Seed yield	Stalk yield (Kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index %
Nitrogen (N kg/ha)				
0	1011.92	2861.00	3868.50	26.15
20	1045.25	2977.67	3996.50	26.30
40	1519.58	4307.00	5808.83	26.38
60	1028.25	3001.67	4049.50	26.12
SE (D)	128.86	367.56	489.81	0.41
CD(P=0.05)	263.16	750.67	1000.32	
Potassium (K_2O kg/ha)				
0	1072.92	3041.75	4128.08	25.89
10	1156.92	3276.25	4416.58	26.30

20	1197.25	3400.50	4566.08	26.45
30	1207.92	3428.83	4612.58	26.32
SE(D)	128.86	367.56	489.81	25.89
CD(P=0.05)	263.16	750.67	1000.32	

Net returns

Nitrogen: Data presented in table 6 showed that N application upto 40 kg/ha brought about significantly higher net returns (□ 58350 ha^{-1}) and B:C ratio (3.9) over the lower levels. The enhancement in net returns due to the above level was □ 26,775 and □ 7908 over 20 kg N ha^{-1} and control, respectively.

Potassium: Results presented in table 6 revealed that graded levels of potassium upto 20 kg ha^{-1} resulted in significantly higher net returns and B: C ratio over lower levels. The significantly higher net returns (56368) and B:Cratio (3.8) recorded at this level of potassium were also at par with 30 kg K_2O ha^{-1}. Hence, 20kg K_2O ha^{-1} was the most remunerative dose.

Table 6: Effect of nitrogen and potassium on net returns and B:C ratio of treatments

Treatment	Net returns (□/ha)	B:Cratio
Nitrogen (N kg/ha)		
0	31574	2.6
20	50442	3.5
40	58350	3.9
60	61058	4.0
SEm±	1923	0.1
CD(P=0.05)	5537	0.3
Potassium (K_2O kg/ha)		
0	37042	2.9
10	50105	3.5
20	56368	3.8
30	57911	3.8
SEm±	1923	0.1
CD(P=0.05)	5537	0.3

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