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Effect of Potassium and Sulphur on economics and optimum does of Sesame (*Sesamum indicum* L.)

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Abstract
A field experiment was conducted at Agronomy farm, S.K.N. college of Agriculture, Jobner (Rajasthan) during *kharif* 2014 on loamy sand soil. The experiment consisted 16 treatment combinations of four levels each of potassium (0, 25, 50 and 75 kg ha^{-1}) and sulphur (0, 20, 40 and 60 kg ha^{-1}).The results showed that according to economic and marginal analysis, progressive increase in level of potassium upto 50 kg K_2O ha^{-1} and sulphur 40 kg S ha^{-1} seemed highly practical due to higher net returns, benefit-cost ratio (BCR) and optimum dose of potassium and sulphur for sesame crop were computed as 63.94 kg K_2O ha^{-1} and 53.93 kg S ha^{-1}, respectively

Keywords: Potassium, Sulphur, Economics and Optimum does

Introduction
Sesame is called as 'the queen of oils' because of extra ordinary cosmetic and skin care qualities. It is grown in all seasons of the year and 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]. Potassium plays an important role in activation of enzymes and resistance to cold, disease, water stress and other adverse conditions. Sulphur an essential plant nutrient can play a key role in augmenting the production and productivity of oilseeds in the country as it has a significant influence on quality and development of oil seeds and best known for its role in the synthesis of proteins, oils and vitamins. 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 Method
A field was conducted at the Agronomy farm, S.K.N. College of Agriculture, Jobner (Raj.) in a randomized block design, with four replication using sesame cv. RT-46. There were 16 treatments consisting of four levels of K (0,25,50 and 75 kg K2O/ha applied as gypsum) and four levels of S (0,20,40 and 60 kg S/ha applied as sulphate of potash) experimental soil was loamy sand in texture with high infiltration rate (22.4 cm hr^{-1}) and saturated hydraulic conductivity 10.20 cm hr^{-1}. The soil was low in organic carbon (0.21%), low available nitrogen (125.64 kg N ha^{-1}), medium in available phosphorus (18.43 kg P_2O_5 ha^{-1}) and in available potassium (178.05 kg K_2O ha^{-1}) while the soil was deficient in available sulphur (7.95 mg kg^{-1}). The soil was non saline with a reaction 8.2. All the treatments i.e. levels of sulphur after adjusting sulphur received from potassium sulphate applied through gypsum 21 days before sowing and potassium as per treatments were applied prior to sowing and incorporated manually in top 15 cm soil. The recommended dose of N and P in the form of urea and DAP were applied through broadcasting before sowing. The crop was raised with standard package of practices. The crop was harvested at maturity and plot wise fodder and grain yield recorded after sun dry as well as plant height, number of branches per plant, number of capsule per plant, number of seed per capsule and 1000 seed test weight were also recorded.
Economics the gross realization in term of rupees per hectare was worked out separately for each treatment considering the yields of seed and stalk and their respective prices prevailed during the month of November 2014. Likewise, the cost of cultivation was worked out by considering the expenses incurred on routine operations from preparatory tillage to harvesting including threshing, cleaning as well as the cost of inputs viz., seeds, fertilizers etc. The total cost of cultivation was deducted from the gross realization to work out the net income for each treatment combinations and was recorded accordingly. The benefit cost ratio (BCR) was calculated on the bases of following formula.

$$\textbf{Benefit cost ratio (BCR)} = \frac{\text{Net returns}}{\text{Cost of cultivation}}$$

Result and Discussion
The results obtained from the present investigation are presented in Table 1 and 2.

Net return
The application of potassium and sulphur had significant effect on the net return of the sesame crop (Table1). The significantly highest net return of the crop was observed as 39885 Rs ha^{-1} under the treatment K_{50} while minimum was observed as 29225 Rs ha^{-1} under K_0 (control). The maximum increase in the net return was recorded as 36.47 % higher over control with the application of potassium @ 50 kg K_2O ha^{-1} (K_{50}). The treatment K_{50} and K_{75} were found to be statistically at par with each other.
The net return was also significantly influenced with the application of sulphur. The significantly maximum net return was observed as 40525 Rs ha^{-1} under the treatment S_{40} while minimum net return was observed as 26955 Rs ha^{-1} under control (S_0). The treatment S_{40} and S_{60} were statistically at par.

B: C ratio
The data clearly indicated that application of potassium and sulphur at increasing level significantly influenced the B: C ratio of the sesame crop (Table 1). The significantly maximum B: C ratio of the crop was recorded as 2.29, 2.38 with the application of potassium @ 50 kg K_2O ha^{-1} (K_{50}) and sulphur @ 40 kg ha^{-1} (S_{40}) over control, respectively. While minimum B:C ratio was recorded as 1.88 and 1.59 under the treatment of potassium K_0 and sulphur S_0, respectively. The data further indicated that the per cent increase in B: C ratio was recorded as 21.80 % higher over control with the application of potassium @ 50 kg K_2O ha^{-1} (K_{50}). The treatment K_{50}, K_{75} and S_{40}, S_{60} were found statistically at par.
The increase in net return might be due to the direct result of higher sesame yield (Table 1). Higher marginal rate of return with potassium and sulphur application @ 50 kg K_2O ha^{-1} and 40 kg S ha^{-1} indicated higher output per unit of K and S input at the level (Shah *et al.*, 2013) [6].

Optimum dose
Response of seed yield to varying levels of potassium and sulphur was worked out and found to be the quadratic. The functional form of yield response to potassium and sulphur is given in table 2. The perusal of data (Table 2) showed that the economic optimum dose of potassium and sulphur was recorded as 63.94 kg ha^{-1} and 53.65 kg ha^{-1}, respectively with their corresponding seed yields of 835.90 and 837.77 kg ha^{-1}.
The application of potassium at increasing rate significantly increased the available potassium status of the soil and significantly maximum available potassium was recorded with the application of potassium @ 75 kg ha^{-1} (Table 2). The significant increase in available potassium nutrient status of soil due to application of potassium might be due to solubilization of native status of potassium (Gajghane *et al.*, 2015) [2] and due to positive interaction with other supplemental nutrients (Veeramani *et al.*, 1989) [9]. Such increase in available potassium status of the soil at harvest of the crop may also be due to direct addition of potassium to available pool of the soil (Tandon, 1987) [7].
The available sulphur status of the soil was significantly influenced with the application of sulphur at increasing rate (Table 2). The significantly maximum available sulphur status of the experimented soil at harvest of the crop was recorded with application of sulphur @ 60 kg ha^{-1}. The available status of S significantly increased with sulphur application. This increase might be due to amelioration effect of sulphur and improved physicochemical properties of soil. The higher amount of available sulphur coated be attributed to a greater mineralization of organic sulphur and release of SO_4^{2-} ions on its gradual oxidation (Pathan and Nag, 2008) [4]. Similar findings were also reported by Vaghani *et al.* (2010) [8], Najar *et al.* (2011) [5] and Jena *et al.* (2006) [3].

Table 1: Effect of potassium and sulphur on net returns and B:C ratio of sesame

Treatments	Net returns (Rs ha^{-1})	B:C ratio
Potassium levels		
K_0	29225	1.88
K_{25}	35815	2.17
K_{50}	39885	2.29
K_{75}	40175	2.20
SEm±	831	0.04
CD (P=0.05)	2401	0.11
Sulphur levels		
S_0	26955	1.59
S_{20}	36085	2.13
S_{40}	40525	2.38
S_{60}	41535	2.44
SEm±	831	0.04
CD (P=0.05)	2401	0.11

Table 2: Seed yield (Y) as a function of potassium and sulphur fertilization ($Y = b_0+b_1 X b_2 X^2$)

Study parameters	Potassium	Sulphur
1. Partial regression coefficients		
b_0	639.1	626.9
b_1	5.324**	7.82**
b_2	-0.036*	-0.072*
2. Coefficients of multiple correlation (R)	0.999**	0.999**
3. Optimum level (kg/ha)	63.94	53.65
4. Yield at optimum level (kg/ha)	832.34	837.76
5. Response of optimum level (kg/ha)	193.24	210.86

Note:-
The yield, K and S levels, responses and intercepts are given in kg ha^{-1}
* Significant at 5% level of significance
** Significant at 1% level of significance

Conclusion
Based on the experimental results, it was concluded that crop of sesame in semi-arid region with higher net return can be obtained by the application of potassium @ 50 kg K_2O ha^{-1} and sulphur @ 40 kg S ha^{-1}, whereas, optimum dose of potassium and sulphur for sesame crop were computed as 63.94 kg K_2O ha^{-1} and 53.93 kg S ha^{-1}, respectively.

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