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Effect of potassium and sulphur nutrition on yield and uptake of nutrients in Indian mustard (*Brassica juncea*) in Inceptisol

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ABSTRACT

A field experiment was conducted during Kharif season of 2014 and 2015 at Panwari Village (Agra) tostudy the effect of potassium and sulphur on growth, yield, quality and nutrient uptake in Indian mustard (Brassica funcea (L) (Czernj & Cosson). The experiment was laid out in randomized block design with four levels each of K (0, 30, 60 and 90 kg K_2O ha^{-1}) and sulphur (0, 20, 40 and 60 kg S ha^{-1}) and three replications. The results revealed that the mean seed and stover yields of mustard with 60 kg K_2O ha^{-1} were 26.4 and 22.4 % higher than the control, respectively. Increasing levels of sulphur up to 40 kg S ha^{-1} showed significant improvement in yields of mustard. Application of 40 kg S ha^{-1} resulted in 22.9 % increase in seed yield than the yield obtained in the control (1.60t ha^{-1}). The corresponding increase in stover yield of mustard was 23.6 per cent, over control. The content and yield of protein in mustard seed increased significantly with the addition of K and S. The nutrient uptake in mustard seed and stover increased significantly with increasing levels of S and maximum uptake values were recorded with 60 kg S ha^{-1}. The uptake of N, P, K and S in mustard crop increased significantly with K application over control.

Keywords: Nutrient uptake, potassium, quality, mustard, sulphur, yields

INTRODUCTION

Mustard (*Brassica juncea*) is the second most important oil seed crop, containing about 25-30% of the total oil seed production in the country. The production of mustard is quite lower in our country mainly due to sub-optimal application of fertilizers and cultivation on marginal lands. Potassium and sulphur play an important role in oil seed crops and these crops respond well to applied potassium and sulphur (Mishra, 2003, Singh *et al.* 2017). Potassium is important for growth and yield of crops as the quantity of K absorbed by roots is second to that of nitrogen. Potassium is required for improving the yield because of its role in photosynthesis, water use efficiency and plant tolerance to diseases, drought and cold as well for making the balance between protein and carbohydrates. Sulphur plays an important role in growth and development of crops. It plays an important role in the formation of S – containing amino acids like cystine (27% S), Cysteine (26.0% S) and metheonine (21% S), which act as building blocks in the synthesis of protein. It has role to play in increasing chlorophyll formation and aiding photosynthesis. It is also responsible for synthesis of certain vitamins (B, biotin and Theamine), metabolism of carbohydrates protein and oil formation in crucifers. Brassica has the highest sulphur requirement owing to the presence of sulphur rich glucosinolates. So far, inadequate information is available regarding the effect of potassium and sulphur on mustard in Agra condition. Therefore, a study was conducted to evaluate the effect of potassium and sulphur on the yield, quality and nutrient uptake in mustard.

MATERIALS AND METHODS

A field experiment was conducted during rabi season of 2015-16 and 2016-17 at Pernwari, Agra (U.P.). The experimental site falls under South-West semi-arid zone and characterized by semi-arid climate with extreme temperature during summer (45 to 48° C) and very low temperature during winter (as low as 2° C). The experimental soil was sandy loam in texture having pH 7.9, organic carbon 3.2 g kg^{-1}, available N 160 kg ha^{-1}, available P 8.5 kg ha^{-1}, available K 108 kg ha^{-1} and available S 12.2 kg ha^{-1}. The sixteen treatment combinations which were tried in mustard consisted of potassium as muriate of potash at four levels (0, 20, 40 and 60 kg K_2O ha^{-1}) and sulphur as elemental sulphur at four levels (0, 10, 20 and 40 kg S ha^{-1}). The experiment was laid out in randomized block design with three replications. A basal dose of 100 kg N and 60 kg P_2O_5 for mustard was applied uniformly in all the plots through urea and single superphosphate, respectively. The mustard crop

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was sown in third week of October in both the years. Potassium and sulphur were applied as per treatments at the time of sowing. Appropriate management practices were adopted to raise the crop. The crop was harvested at maturity. The seed and stover yields were recorded. The seed and stover samples were digested in di-acid (HNO_3: $HClO_4$, 10:4) mixture and analysed for P by vanadomolybdate yellow colour method (Jackson 1973), K by flame photometer, S by turbidimetric method (Chesnin and yien 1951). Nitrogen content in crop was determined by Kjeldahl method. The oil content in mustard seed was determind using soxhlet apparatus. The uptake of nutrients was obtained as product of their concentrations and yield. The data generated for both the growing seasons were pooled and statistically analyzed (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Data (Table 1) revealed that the seed and stover yield of mustard increased significantly with potassium application over the control and maximum seed (1.96 t ha^{-1}) and stover (5.61 t ha^{-1}) yields were recorded with 60 kg K_2O ha^{-1}. The mean seed and stover yields of mustard increased by 26.4 and 22.5 % over control owing to addition of 60 kg K_2O ha^{-1}. The favorable effect of K on yield of mustard was mainly due to its essential role in seed development. These results confirm the findings of Mishra (2003) and Singh *et al.* (2017). A significant increase in seed and stover yield of mustard was found with the addition of S over control (Table 1). The highest seed and stover yields were recorded under 40 Kg S ha^{-1} which registered 22.9 and 23.6 % higher seed and stover yield over the control (1.60 and 4.0 ha^{-1}). Both the levels of S (40 and 60 kg ha^{-1}) were statistically at par in respect of yields of mustard crop. The increase in yield might be due to stimulatory effect of sulphur on the synthesis of Chloroplast and protein which inturn might have promoted greater photosynthesis and ultimately resulting in higher yield (Singh *et al.* 2017).

Table 1: Effect of potassium and sulphur levels on yield and quality of mustard (mean of 2 years

Treatment	Yield (t ha^{-1})		Protein content (%)	Protein yield (kg ha^{-1})	Oil content (%)	Oil yield (kg ha^{-1})
	Seed	Stover				
Potassium (kg ha^{-1})						
0	1.55	4.58	19.5	302.2	39.6	613.8
30	1.75	5.05	19.5	341.2	40.0	700.0
60	1.96	5.61	19.8	388.1	40.4	791.8
90	1.94	5.68	20.0	388.0	40.6	787.6
CD(P=0.05)	0.19	0.43	0.03	14.2	0.25	27.5
Sulphur (kg ha^{-1})						
0	1.60	4.61	19.2	307.2	39.3	628.8
20	1.75	5.07	19.5	341.2	39.5	691.2
40	1.92	5.67	19.9	382.0	40.4	775.6
60	1.93	5.58	20.1	387.5	40.8	787.4
CD(P=0.05)	0.19	0.43	0.03	14.2	0.25	27.5

Quality

Increasing levels of K and S significantly increased the protein content in mustard seed from 19.5 to 20.0% with 90 kg K_2O ha^{-1}. The corresponding increases in protein content in mustard seed with 60 kg S ha^{-1} was from 19.2 to 20.1 per cent. Sulphur is an intgral part of amino acids viz. cysteine, Cystine and methionine. Therefore, its application enhanced the amount of protein in mustard seed leading to highest protein. Similar results were reported by Singh *et al.* (2017) in mustard crop. Corresponding application of K and S also increased the protein yield from 302.2 to 388.0 and 307.2 to 387.5 kg ha^{-1}, respectively. The increasing protein yield was significant up to 60 kg K_2O and 40 kg S ha^{-1} over the control. Protein yield is the function of protein content and seed yield. Since, variation in protein content has genetic and bio-chemical limitation. The protein yield is more influenced by seed yield and thus followed almost trend similar to seed yield.The oil content of mustard seed increased significantly with the highest level of K over control (Table 1). The maximum value of oil content in seed was recorded with 90 kg K_2O ha^{-1} whereas the minimum was in control (39.6%). Both the levels of K (60 and 90 kg KO ha^{-1}) were

statistically at par with respect to oil content in mustard seed. Oil content in seed increased significantly with sulphur application and the maximum value (40.8%) was recorded with 60 kg S ha^{-1}. Sulphur is a constituent of glucosinolate which plays vital role in synthesis of mustard oil. These results are in agreement with the finding of Singh *et al.* (2020). The oil production increased significantly with increasing levels of K and maximum oil yield (791.8 kg ha^{-1}) was recorded with 60 kg K_2O ha^{-1}. Similarly application of S increased the oil yield from 628.8 to 787.4 kg ha^{-1} with 60 kg S ha^{-1}. Positive effect may be attributed to marked improvement in seed yield with K and S application (Kushwaha *et al.* 2019).

Table 2: Effect of Potassium and sulphur on uptake of nutrients (kg ha^{-1}) by mustard crop (mean of 2 years)

Treatment	Nitrogen		Phosphorus		Potassium		Sulphur	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
Potassium (kg ha^{-1})								
0	48.0	27.9	9.0	8.5	10.2	90.7	9.3	9.9
30	54.4	31.3	10.5	9.7	11.8	104.3	10.7	11.1
60	61.5	35.2	11.9	11.1	14.0	119.2	12.0	13.3
90	61.6	37.4	12.2	11.6	14.9	123.7	12.6	14.5
CD(P=0.05)	2.29	1.39	0.55	0.69	1.59	7.25	1.42	1.52
Sulphur (kg ha^{-1})								
0	49.2	27.3	9.3	8.6	11.1	96.6	9.3	9.7
20	54.2	31.5	10.4	9.8	12.3	104.8	10.6	11.3
40	60.0	35.5	11.5	10.8	13.4	114.7	11.9	13.2
60	61.3	37.1	12.4	11.7	14.1	121.9	12.7	14.6
CD(P=0.05)	2.29	1.39	0.55	0.69	1.59	7.25	1.42	1.52

Uptake of nutrients

Nitrogen uptake by mustard seeds increased significantly with the increasing levels of K up to 90 kg K_2O ha^{-1} over the control and the increases were 21.3, 28.0 and 28.3 % due to 30, 60 and 90 kg K_2O ha^{-1}, respectively. Singh *et al.* (2017) also reported similar results. The N uptake by seed and stover increased from 49.2 to 61.3 kg ha^{-1} and from 27.3 to 37.0 kg $ha^{-1}$with 60 kg S ha^{-1}. This increase in N uptake may be ascribed to the higher seed and stover production as well as improvement in N content with S addition (Sahoo *et al.* 2018). Phosphorus uptake by mustard seed and stover increased significantly over control due to increasing levels of K up to 90 kg K_2O ha^{-1}. The results indicated a beneficial effect of K on the absorption of phosphorus by the crop. Similar results were reported by Singh *et al.* (2020). The phosphorus uptake by mustard crop tended to increase with sulphur application over control and the increases in P uptake by seed and stover were 33.3 and 36.0 % respectively with 60 kg S ha^{-1}. The increase in P uptake is apparently the result of favourable effect of S on P absorption coupled with greater seed and stover production Rakesh and Banik (2016) and Singh *et al.* (2015) reported similar results.

The K uptake by the mustard seed and stover increased from 10.2 to 14.9 and from 90.1 to 123.7 kg ha^{-1}, respectively as the dose of K was increased from 0 to 90 kg K_2O ha^{-1}. This increase in K uptake by the crop may be attributed to increased absorption by plants from the soil. Similar results were reported by Singh *et al.* (20Si17) and Mishra (2003).The addition of S also increased the uptake of K by mustard seed and stover over control and maximum value of K uptake by seed (14.1 kg ha^{-1}) and stover (121.9 kg ha^{-1}) were recorded with 60 kg S ha^{-1}. Similar results were reported by Kumar *et al.* (2012) and Singh *et al.* (2017).The maximum uptake of S by seed (12.6 kg ha^{-1}) and stover (14.5 kg ha^{-1}) was recorded with 90 kg K_2O ha^{-1} and minimum (9.3 and 9.9 kg ha^{-1}) in control. The increase in S content and yield of mustard crop due to K application led to an increased uptake of S (Mishra, 2003). The highest S uptake by seed and stover was recorded with 40 kg S ha^{-1} which was statistically on par with 60 kg S ha^{-1} but significantly superior to control (Table 2). This may be attributed to better growth and higher seed and stover yield under these S treatments.

The minimum S uptake by the crop was recorded under control. Basumatary *et al.* (2019) also reported higher S uptake with S application in mustard.

It may be concluded from the results that in sandy loam soil deficient in K and S, application of K and S are required to harvest optimum crop yield, nutrient uptake and quality of produce. Application of 60 kg K_2O ha^{-1} and 40 kg S ha^{-1} was found optimum dose for maintaining higher seed yield and quality in light textured soil of Agra region of Uttar Pradesh.

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