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Research Communication

Yield, nutrient uptake and economics of Indian mustard (*Brassica juncea*) as affected by split and foliar application of potassium

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ABSTRACT

A field experiment was carried out during winter (*rabi*) season 2021–22 at the ICAR-Indian Agricultural Research Institute located at New Delhi to find out the effect of potassium management on yields, nutrient uptake and economics of Indian mustard. Eight treatments combinations of different doses, methods and time of potassium application i.e. No K = 0 kg K/ha; 100% MOP (muriate of potash) as basal; 2 Foliar sprays of KNO_3 at branching and before flowering; 50% MOP as basal + 50% MOP as top dressing at branching; 50% MOP as basal + 2 foliar sprays of KNO_3 at branching and before flowering; 75% MOP as basal + 25% MOP as top dressing at branching; 75% MOP as basal + one foliar spray of KNO_3 at branching; 75% MOP as basal + one foliar spray of KNO_3 before flowering were tested. Grain (1.89 t/ha) and straw yields (6.74 t/ha), harvest index (21.88%) and NPK uptake (93.9, 18.5 and 113.3 kg/ha) were significantly higher under 75% MOP as basal + one foliar spray of 2.5% KNO_3 before flowering. However, the treatment i.e. 75% MOP as basal + one foliar spray of KNO_3 before flowering remained significantly at par with 75% MOP as basal + one foliar spray of KNO_3 at branching and 75% MOP as basal + 25% MOP as top dressing at branching in yield and profitability term. Enhanced net returns amounting to 65,873/ha and a benefit: cost ratio of 1.86 were recorded on the application of 75% MOP as basal fertilizer combined with a single foliar spray of KNO_3 before flowering. This remained comparable to most treatments, except the control, 100% MOP applied as basal, the method involving two foliar sprays of KNO_3 at branching and before flowering, 50% MOP as basal combined with 50% MOP as top dressing at branching, and the approach combining 50% MOP as basal with 2 foliar sprays of KNO_3 at branching and before flowering.

Key words: Indian mustard, Nutrient uptake, Potassium, Yield

The cultivation of Indian mustard (*Brassica juncea*) holds significant agricultural importance owing to its diverse applications in food, oil, and biofuel industries. Understanding the dynamics of nutrient management, particularly potassium (K), is crucial for optimizing yield, nutrient uptake efficiency, and economic returns in Indian mustard cultivation. Potassium (K) regulates the opening and closing of stomata thus, regulating the uptake of CO_2 and enhancing photosynthesis. It triggers activation of important biochemical enzymes for the generation of Adenosine Triphosphate (ATP). ATPs provides energy for other chemical and physiological processes, such as, excretion of waste materials in plants. It plays a role in osmoregulation of water and other salts in plant tissues and cells. Potassium helps to increase drought tolerance in plants by affecting plant-soil-water relationship besides yield advantage. K promotes root growth, increases biomass and improve water use efficiency (Jakli *et al.,* 2016). Most of the recommendations suggested that entire dose of potassium should be applied as basal application but some recent research suggests that in addition to basal K application, the top dressing and foliar application of K has immense potential. Split application and foliar supplementation of potassium have emerged as promising strategies to enhance crop productivity and resource use efficiency (Vijayakumar *et al.,* 2019a, 2019b, 2024). This study investigated the impact of split and foliar application of potassium on the yield, nutrient uptake, and economic performance of Indian mustard, aiming to provide valuable insights for sustainable agronomic practices and improved crop management strategies in Indian mustard cultivation.

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A field experiment was carried out during the winter (*rabi*) season 2021-22 to investigate the effect of potassium management on Indian mustard at the ICAR-Indian Agricultural Research Institute at New Delhi. The soil of the experimental site was sandy loam in texture with neutral *p*H of 7.1, organic carbon (0.53%), available nitrogen (208 kg/ ha), available phosphorus (13 kg/ha) and available potassium (222 kg/ha). The field experiment was laid-out in Randomised Complete Block Design with three replications. There were eight treatments combinations of different doses, methods and time of potassium application i.e. T_1, 0 kg K/ha; T_2, 100% MOP as basal (33.2 kg K/ha); T_3, 2 Foliar sprays of KNO_3 at branching and before flowering (8.8 kg K/ha); T_4, 50% MOP as basal + 50% MOP as top dressing at branching (33.2 kg K/ha); T_5, 50% MOP as basal + 2 foliar sprays of 2.5% KNO_3 at branching and before flowering (25.4 kg K/ha); T_6, 75% MOP as basal + 25% MOP as top dressing at branching (33.2 kg K/ha); T_7, 75% MOP as basal + one foliar spray of KNO_3 at branching (25.4 kg K/ha); T_8, 75% MOP as basal + one foliar spray of KNO_3 at before flowering (25.4 kg K/ha). The recommended dose of potassium (RDK) for mustard is 33.2 kg K/ha. Sowing of the mustard variety 'Pusa Tarak' was done on 8 October, 2021 with seed drill. A seed rate of 6 kg/ha was used under planting spacing of 45 cm for row to row and 20 cm for plant to plant. The crop was harvested from each net plot separately on 17th February 2021 and was dried for 5 days in sun. The grain yield was deducted from the biological yield of the corresponding plots to get the stover yield and was expressed in t/ha. The harvest index was worked out as the ratio of economic produce i.e., grain yield to the biological yield. The plant samples of seed and stover (leaves + stem) collected from each treatment at harvest were dried in hot air oven at 60°C for 48 hours. The oven-dried samples were taken for chemical analysis to determine macronutrients concentration. Total nutrient uptake was obtained by summing up the amounts removed in stover and seed (kg/ha). Operating cost of cultivation was obtained by adding the cost of variables involved in each operation like ploughing, sowing, fertilizer application, weeding operations or input like fertilizers, herbicides etc. Gross returns were calculated by converting the grain and straw yields of the mustard into monetary aspects on the basis of minimum support price for mustard grains and prevailing market price for stover. The data were subjected to statistical analysis by using the standard technique of analysis of variance (ANOVA), and their significance was tested using F-test (Gomez and Gomez, 1984). Standard error of means (SEm±) and critical difference ($P \leq 0.05$) were worked out to judge the differences between treatment means.

The result revealed that basal application as well as basal + foliar application of K resulted in significant increase in the mustard yield (Table 1). Soil application of 75% MOP as basal + one foliar spray of 2.5% KNO_3 before flowering recorded the higher grain yield and was found 42.10% superior over 100% MOP as basal and 68.75% over control. Improved crop performance by basal application of K might be due to increased crop and root growth which further increased the uptake of nutrients. Foliar application might have improved the K availability to plants at reproductive stages and therefore, resulted in more yield**.** Moreover, the yield enhancement in split or foliar spray treatments was higher largely due to increased number of branches, siliquae per plant, and number of seeds per siliqua. The results are in close conformity with the findings of Vijayakumar *et al.* (2019b) and Gour *et al.* (2019). Addition of 75% MOP as basal + one foliar spray of KNO_3 before flowering also recorded significantly higher harvest index. However, this treatment remained significantly at par with 75% MOP as basal + one foliar spray of KNO_3 at branching and 75% MOP as basal + 25%

Table 1. Yield, nutrient uptake and economics of Indian mustard as affected by potassium management

Treatment*	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)	Cost of cultivation (₹/ha)	Net returns (₹/ha)	Net benefit: cost
T_1	1.12	5.87	16.03	55.97	12.32	66.09	34,343	27,499	0.80
T_2	1.33	6.07	17.96	69.78	14.31	77.86	35,201	37,386	1.06
T_3	1.15	5.95	16.18	58.91	12.85	67.54	35,479	27,868	0.79
T_4	1.63	6.57	19.89	81.52	16.17	95.09	35,201	53,082	1.51
T_5	1.64	6.59	19.90	82.81	16.53	95.99	35,758	52,805	1.48
T_6	1.83	6.56	21.83	89.56	17.45	106.41	35,201	63,207	1.80
T_7	1.85	6.63	21.84	91.39	17.88	110.28	35,479	64,069	1.81
T_8	1.89	6.74	21.88	93.89	18.52	113.31	35,479	65,873	1.86
SEm±	0.051	0.209	0.634	2.495	0.513	3.115	-	1,656.6	0.05
CD (P=0.05)	0.155	0.633	1.922	7.569	1.556	9.448	-	5,024.7	0.14

*Treatment details are given under materials and methods section.

MOP as top dressing at branching. Higher harvest index of mustard in split and foliar spray treatments indicates greater partitioning of photo-assimilate to the reproductive plant parts rather than the generation of whole-plant biomass. This finding is in close conformity with the results of Gifford *et al.* (1984). Harvest index was lower in control which was at par with 2 foliar sprays of KNO_3 at branching and before flowering. The total N, P and K uptake by the crop was higher under 75% MOP as basal + one foliar spray of KNO_3 before flowering; 75% MOP as basal + 1 foliar spray of KNO_3 at branching and 75% MOP as basal + 25% MOP as top dressing at branching. The lower total N, P and K uptake was observed in control which was at par with 2 foliar sprays of KNO_3 at branching and before flowering. The uptake of N, P and K by mustard increased with increasing rate of K application mainly due to higher total dry matter production and grain yield. Meena *et al.* (2022) and Bhanuwanti *et al.* (2022) also reported enhanced uptake of N, P and K with increasing level of K application. Optimum N: K ratios favours vigorous plant growth and development, and ensures efficient utilization of applied fertilizers (Xie *et al.,* 2000).

Higher cost of cultivation was recorded in the treatment 50% MOP as basal + 2 foliar sprays of KNO_3 at branching and before flowering, whereas, control recorded the lowest production cost (Table 1). Application of 75% MOP as basal + one foliar spray of 2.5% KNO_3 before flowering has recorded significantly higher profitability in terms of net returns as well as benefit: cost ratio and it was 28,487/- net gain over 100% MOP as basal Sharma and Thakral (2023).

Thus, the findings of this study highlight the importance of strategic potassium management through split and foliar applications in enhancing yield, nutrient uptake, and economic returns of Indian mustard cultivation.

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