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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(2): 180-182

www.thepharmajournal.com
Received: 04-11-2021
Accepted: 10-01-2022

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Response of nitrogen, phosphorus and potassium on quality parameters and economics analysis of Indian mustard (*Brassica juncea* (L.) Czern and Coss.)

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Abstract

A field experiment on different fertilizer levels *viz*., three levels of nitrogen (80, 100 and 120 kg N ha^{-1}), two levels of phosphorous (40 and 50 kg P_2O_5 ha^{-1}) and three levels of potassium (15, 30 and 45 kg K_2O ha^{-1}) carried out during *Rabi* season 2019-20 at Agricultural Research Station Ummedganj, Kota, Rajasthan. The experimental results revealed that application of 120 kg N ha^{-1} was recorded significantly higher protein content, protein yield, oil content, oil yield, net return and B: C ratio over 80 kg N ha^{-1} however, it was remained at par with 100 kg N ha^{-1}. The non-significant differences was recorded between 40 and 50 kg P_2O_5 ha^{-1} for all quality parameters except oil yield, significantly higher net return was obtained with 50 kg P_2O_5 ha^{-1}. The application of 45 kg K_2O ha^{-1} was produced significantly higher oil content, protein content, net return and B:C ratio over 15 kg K_2O ha^{-1}however, it was remained at par with 30 kg K_2O ha^{-1}. Hence, application of 100 kg N ha^{-1}, 50 kg P_2O_5 and 30 kg K_2O ha^{-1} was found most remunerative treatment combination for getting maximum net return.

Keywords: Indian mustard, net return, oil content, protein content

Introduction

Indian mustard is important oilseed crop and currently ranked as the world's third important oilseed crop in term of production and area. Importance of oilseed in agriculture needs further attention, as they are valuable items of human nutrition and soil fertility. In India, rapeseed-mustard is grown over 5.96 million ha area with a production of 8.32 million tonnes at an average productivity of 1397 kg ha^{-1} (GOI, 2017-18). It is the most important *Rabi* season oilseed crop of Rajasthan which is grown on 2.38 mha with annual production of 3.95 mt at an average productivity of 1656 kg ha^{-1} (Anonymous, 2019-20) [2]. The optimum sowing time of Indian mustard in south-eastern Presently in south-eastern Rajasthan Indian mustard (*Brassica juncea*) is being grown on *vertisols* under irrigated conditions after harvest of urdbean /soybean without considering nutrient management which is essential for harvesting good yield. Unnecessary use of chemical fertilizers especially macro nutrients not only lowers productivity but also adversely affects soil health by continuous. Decline in crop yield due to lack of K supply was reported even in K rich soils like Vertisols (Singh and Wanjari, 2012) [10], the declining in crop yield, responsible for lower net return and B: C ratio. Furthermore, the inadequate supply of K also limits the responses to applied N and P fertilizer. Nitrogen deficiency may decrease yield while, excess N availability reduces the oil quality. Under the present situation application of major nutrient elements NP&K is essential for increasing mustard yield and maintaining crop production at higher level in irrigated condition. Considering these facts, the present study was therefore, undertaken to evaluate the effect of major nutrient N,P&K management for Indian mustard grown on *Vertisol* after harvest of urdbean in irrigated areas of south -east Rajasthan.

Materials and Methods

A field experiment was conducted at Agriculture Research Station, Kota (26º North latitude, 76º-6' East longitude and 260 m above mean sea level) during the *Rabi* seasons of 2019-20 to study the effect of different levels of nitrogen, phosphorous and potassium nutrient management on growth, yield attributes, yield, quality and economics of Indian mustard grown in higher clay content soil of south-east Rajasthan under irrigated condition. The experimental soil was clay loam in texture with a pH of 7.95, medium in organic carbon (0.54%), available nitrogen (280 kg ha^{-1}), phosphorus (40.3 kg ha^{-1}) and high in potassium (400 kg ha^{-1}), zinc (0.92 mg/kg soil) and low in sulphur (8.85 kg ha^{-1}) contents. The experiment comprised of 18 treatments with three levels of nitrogen *viz.*, 80, 100 and 120 kg ha^{-1}, two levels of phosphorous fertilizer *viz.*, 40 and 50 kg ha^{-1} in main plots, and three levels of potassium fertilizer *viz.*, 15, 30 and 45 kg ha^{-1} in sub plots were assigned in sub-sub plots and laid out in split-plot design with 3 replication. Uniform application of FYM with treatment doses of NP&K were supplied through urea, dia-ammonium phosphate, muriate of potash, respectively. Full dose of P_2O_5, K_2O and half N were applied as basal at planting and half dose of N was top-dressed at 40 days after planting of the crop as per treatments. 5 kg ha^{-1} seed of variety 'DRMRIJ 31' was used. The gross plot size for each treatment was 6 m x 3.6 m and net plot size was 5 m x 2.7 m. All the recommended agronomic practices were done throughout the crop season. The crop was harvested manually at maturity stage as per treatments. The protein content in seed was work out by multiplying per cent nitrogen in seed with a constant factor 6.25 (A.O.A.C., 1955) [1]. The oil content in mustard seed was determined by Soxhlet's Ether extraction method (A.O.A.C., 1955) [1]. For calculating economics, the acreage treatment yield along with prevailing market rates for inputs and outputs were used. The data were statistically analysed and the results of pooled analysis are presented.

Results and Discussion

Quality parameters

Oil content and protein content in mustard seeds were significantly influenced due to application of graded levels of Nitrogen. The application of 120 kg N ha^{-1} was recorded significantly higher oil content (38.40%), oil yield (1094 kg ha^{-1}), protein content (22.11%) and protein yield (633 kg ha^{-1}) compared to 80 kg N ha^{-1}. However, the differences between 120 kg and 100 kg N ha^{-1} was found non-significant with this respect. The oil yield is the function of oil content in seed and seed yield, the increment in oil and protein content in seeds of mustard may be due to the nitrogen is the basic constituent of protein. Nitrogen application improved the nutritional environment and more nutrient uptake. The similar trends were also reported by Singh and Singh (2018).

The non-significant differences between 40 and 50 kg P_2O_5 ha^{-1} was found with respect to oil content, protein content and protein yield whereas, application of 50 P_2O_5 ha^{-1} was increased significantly oil yield compared to 40 kg P_2O_5 ha^{-1}. Oil yield of mustard was enhanced significantly up to 50 kg P_2O_5 ha^{-1} over 40 k P_2O_5 ha^{-1} of the phosphorous level. An increase in the oil content in mustard seed might be because of synthesis of fatty acids in plants in the presence of ATP and phosphate. These fatty acids play an important role in increasing the oil content of seed. The results are in obedience given by Bharose *et al.* (2011) [3] and Chouksey *et al.* (2017) [5]. The application of different potassium levels has significant effect on quality parameters, the significantly maximum oil content (38.65%), oil yield (1097 kg ha^{-1}), protein content (21.75%) and protein yield (623 kg ha^{-1}) was recorded with 45 kg K_2O/ha over 15 kg K_2O ha^{-1} however, it was found on par with 30 kg K_2O ha^{-1}. Oil yield is function of oil content and seed yield and both the parameters increased with different levels of potassium thus resulted in a significant increase in oil yield. Similar findings were reported by Chauhan and Tikkoo (2002) [4]; Lakhan *et al.* (2017) [9]. The increase in protein content owing to potassium addition might be attributed to its involvement in the nitrogen metabolism. An increase in protein content with potassium application in mustard seeds was reported by Singh (2017). Since variation in protein content has genetic and biochemical limitation, the protein yield is more influenced by seed yield and thus followed almost trent similar to seed yield Singh (2017) in green gram; Lakhan *et al.* (2017) [9] also reported similar results

Economics Studies

Economics returns as a function of seed yield and sale price varied during different years. More returns were obtained due to higher sale price and higher seed yield of Indian mustard. The significantly maximum net returns (₹ ha^{-1}114003) and B: C ratio (4.28) were recorded with 120 kg N ha^{-1} over 80 kg N ha^{-1}nevertheless, it was remained at par with 100 kg N ha^{-1}. The application of 50 kg P_2O_5 ha^{-1} was gave significantly higher net return (₹ ha^{-1}112508) over 40 kg P_2O_5 ha^{-1} whereas, non-significantly increase in B: C ratio with 50 kg P_2O_5 ha^{-1} compared to 40 P_2O_5 ha^{-1}. Among the different levels of potassium fertilization the application of 45 kg K_2O ha^{-1}was significantly higher net return (₹ ha^{-1}113828) and B: C ratio (4.27) over 15 kg K_2O ha^{-1} however, the no significant differences was found between 45 and 30 kg K_2O ha^{-1}. The application of 100 kg N ha^{-1}, 50 kg P_2O_5 and 30 kg K_2O ha^{-1} was found most remunerative treatment combination for getting maximum net return and B: C ratio.

Table 1: Effect of nitrogen, phosphorous and potassium fertilization on oil content, oil yield, protein content, protein yield, net return and B:C ratio of Indian mustard

Treatment	Quality parameters				Economics study	
	Oil content (%)	Oil yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)	Net return (₹ /ha)	B:C ratio
Nitrogen (kg/ha)						
80	36.41	927	19.89	507	99336	3.80
100	38.39	1062	21.33	592	109952	4.17
120	38.40	1094	22.11	633	114003	4.28
S.Em ±	0.18	14.40	0.23	9.97	1862.46	0.07
CD (P=0.05)	0.70	56.51	0.89	39.13	7311.82	0.27
Phosphorous (kg/ha)						
40	37.12	977	20.91	549	103020	3.94
50	38.17	1082	21.31	605	112508	4.23
S.Em ±	0.36	24.38	0.28	17.03	2292.63	0.09
CD (P=0.05)	NS	84.35	NS	NS	7932.34	NS
Potassium (kg/ha)						
15	36.63	939	20.64	530	100328	3.84

30	37.91	1046	20.95	579	109135	4.14
45	38.65	1097	21.75	623	113828	4.27
S.Em ±	0.51	26.04	0.17	13.43	2537.22	0.10
CD (P=0.05)	1.50	76.00	0.51	39.18	7404.50	0.28

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