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Effect of nitrogen and phosphorus application on yield and economics of Indian mustard (*Brassica juncea* L.)

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ABSTRACT

The present field experiment was carried out to study the impact of different levels of nitrogen and phosphorus on yield and economics of mustard (Brassica juncea L) at I T M University Gwalior (M.P.) during rabi season of 2019-20. The experiment was conducted in factorial randomized block design with three replications. The treatments consisted of 3 levels of nitrogen (40, 80 and 120 kg N ha^{-1})and four levels of phosphorus (0,20,40 and 60 kg P_2O_5 ha^{-1}). The results revealed that the application of 120 kg N ha^{-1} recorded significantly maximum number of siliqua / plant (208.50), length of siliqua (5.36cm), number of seeds / siliqua (13.04) and test weight (5.62g). The highest yields of seed (15.70 qha^{-1}) and stover (34.84 q ha^{-1}) were recorded with 120 kg N ha^{-1}. The protein and oil content in mustard seeds also improved with nitrogen and phosphorus application over control. The yield attributes and yield of mustard crop increased significantly with increasing levels of P and maximum seed (15.63 qha^{-1}) and stover yields (35.34 qha^{-1}) were recorded with 60 kg P_2O_5ha^{-1}. There was a significant increase in protein and oil content and maximum values were recorded with 60 kg P_2O_5 ha^{-1}. Highest net profit of Rs. 48515 ha^{-1} was recorded with 120 Kg N ha^{-1} in combination with 60 kg P ha^{-1}while maximum B:C ratio (3.02) was noted with the application of 120 kg N ha^{-1} along with 20 and 40kg P_2O_5 ha^{-1}.

Keywords: Mustard, nitrogen,phosphorus, yield, economics

INTRODUCTION

Mustard Brassica juncea L) is second most important edible oilseed crop after groundnut, accounts nearly 30% of the total oilseeds production in India. India is one of the largest rapeseeds-mustard growing country in the world, occupying the first rank in area and second in production next to China. Total area under rapeseed and mustard in India during 2018-19 was 6.23million hectares with a production of 9.34 million tonnes and productivity of 1499 kg ha^{-1}. The production of mustard is not being fully exploited because of the lack of proper information of nutritional requirement. The important constraints to crop growth are those caused by shortage of plant nutrients. The nutrient requirement of oilseed crops, in general, is very high for almost all the essential mineral nutrients which are to be supplied in adequate quantities. Mustard is very responsive to nitrogen fertilization. Insufficient N availability to mustard plants results in low yields and significantly reduced profits compared to a properly fertilized crop.An optimum supply of nitrogen is important for vigorous vegetative growth, chlorophyl formation and carbohydrate utilization. An adequate supply of available phosphorus in soil is associated with increased root growth. A deficiency of phosphorus will slow overall plant growth and delay crop maturity. Phosphorus is mobile in the plant, so it is absorbed during early growth and is later redirected for use in seed formation. Adequate phosphorus results in rapid growth and early maturity and improves the quality of crop (Ransing *et al.*, 2022). However, information on the effect of nitrogen and phosphorus application on mustard crop in Gwalior is lacking. Hence, a field experiment was conducted to study the effect of N and P on mustard crop.

MATERIALS AND METHODS

A field experiment was conducted on sandy loam soil at Agricultural Research Farm of School of Agriculture, ITM University Gwalior, (M.P.) during *Rabi* season of 2019-20.The soil texture was sandy loam with 60.7% sand, 21.1% silt and 18.2% clay. The soil was low in available nitrogen (182 kg ha^{-1}), medium in available phosphorus (28 kg P_2O_5 ha^{-1}) and rich in

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available potash (286 kg K_2O ha^{-1}).The pH of surface soil was 8.2. The treatments included in the experiment were, 3 levels of nitrogen (40, 80 and 120 kg N ha^{-1}) and four levels of phosphorus (0, 20, 40 and 60 kg P_2O_5 ha^{-1}). Thus, in all 12 treatment combinations were compared in a randomized block design (factorial) with three replications. Full amount of nitrogen and P_2O_5 as per treatment through urea and SSP along with 30 kg K_2O ha^{-1} through MOP were applied at the time of sowing as basal dressing. The mustard variety (NRCDR-2) was sown in furrows 5 cm deep at the distance of 45 cm. with seed rate of 5 kg ha^{-1}. The yield and yield attributes were recorded at harvest. Nitrogen content in seed was determined by Kjeldhal method. The oil content in mustard seed was determined with the help of Nuclear Magnetic Resonance (NMR). Economics of the treatments was computed based on prevalent market prices of inputs used and output realized. The mean of each parameter was compared statistically using analysis of variance. For various parameters the critical difference (CD) among the treatments was worked out (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield attributes and yield

Application of nitrogen significantly increased the number of siliqua / plant over lower dosage of N and maximum number of siliqua was recorded under 120 kg N ha^{-1} and minimum under 40 N kg ha^{-1}. Increasing levels of nitrogen from 40 to 120 kg N ha^{-1} significantly increased the length of siliqua from 4.85 cm to 5.36cm. Similarly application of 120 kg N ha^{-1} resulted in significantly higher values of number of seeds / siliqua and test weight (5.62g) over lower dosage of N. these significant increases in the yield attributes with N levels might be on account of higher uptake of required nutrients. The present findings are in consonance with those of Rajput (2017) and Rajput *et al.* (2018). Phosphorus application significantly improved the yield attributes in terms of number of siliqua / plant, length of siliqua, number of seeds / siliqua and test weight over control. Phosphorus is involved in root development and various metabolic processes of plant resulting in greater meristematic activities and growth, thereby improving yield attributes. Chandan *et al.* (2018) reported similar results.

Table 1: Yield contributing characters of mustard as influenced by various treatments

Treatments		No. of siliquae plant $^{-1}$	Length of siliqua (cm)	No. of seeds siliqua^{-1}	1000 seed weight(g)
Nitrogen (kg ha^{-1})					
40	N_1	175.73	4.85	11.41	4.44
80	N_2	189.15	5.14	12.36	5.06
120	N_3	208.50	5.36	13.04	5.62
SEm±		4.01	0.07	0.21	0.14
CD at 5%		11.75	0.21	0.62	0.41
Phosphorus (kg ha^{-1})					
0	P_0	172.90	4.72	11.38	4.42
20	P_1	185.13	5.00	11.98	4.82
40	P_2	198.12	5.28	12.54	5.28
60	P_3	208.38	5.48	13.17	5.65
SEm±		3.47	0.061	0.182	0.121
CD at 5%		10.18	0.18	0.53	0.36

The application of 80 and 120 kg N ha^{-1} produced significantly higher seed yield ha^{-1} by 26.8 and 40.0 per cent, respectively than 40 kg N ha^{-1}(Table-2). Similar results were obtained by Panotra *et al.* (2016), Rajput (2017) and Rajput *et al.* (2018). The seed yield $plant^{-1}$ is the combined effect of number of siliquae $plant^{-1}$, length of siliquae, number of seeds $siliqua^{-1}$ and 1000 seed weight. Almost all yield contributing characters improved appreciably with increasing levels of phosphorus upto 60 kg P_2O_5 ha^{-1}. The application of phosphorus increased the symbiotic nitrogen fixation power and, in turn, increased number and weight of pods plant^{-1} and 1000 grain weight. Thus, these yield attributes might have resulted in significantly yield attributes which, in turn, may be responsible for higher seed yield. The seed yield with control, 20, 40 and 60 kg P_2O_5 ha^{-1} was 11.2, 13.0,14.4 and 15.6 q ha^{-1}, respectively. This indicated that seed yield appreciably increased with every increase in the rate of phosphorus application up to 60 kg P_2O_5 ha^{-1}. Mustard crop responds well to the application of phosphorus up to 60 kg P_2O_5 ha^{-1}as reported by Panotra *et al.* (2016) and Pal *et al.* (2019).

Table 2: Yield and quality of mustard as influenced by various treatments

Treatments		Seed yield (qha^{-1})	Stalk yield (qha^{-1})	Harvest index (%)	Protein content (%)	Oil Content (%)
Nitrogen (kg ha^{-1})						
40	N_1	11.21	29.03	27.86	18.6	38.1
80	N_2	14.22	33.26	29.95	21.4	38.8
120	N_3	15.70	34.84	31.06	23.6	39.3
SEm±		0.42	0.48	0.98	0.17	0.21
CD at 5%		1.23	1.41	NS	0.51	0.64
Phosphorus (kg ha^{-1})						
0	P_0	11.28	28.78	28.16	19.6	38.3
20	P_1	13.05	31.98	28.98	21.0	38.7
40	P_2	14.48	33.82	29.98	21.6	39.0
60	P_3	15.63	35.34	30.67	23.	39.5
SEm±		0.36	0.41	0.84	0.18	0.24
CD at 5%		1.07	1.22	NS	0.58	0.74

Quality

Protein content in mustard seed increased significantly with nitrogen application and maximum value (23.6%) was recorded with 120 kg N ha^{-1}. Significant increase in seed N content with increasing levels of nitrogen could be attributed to more absorption of N by crop and more translocation of N to seed. Nitrogen being the precursor of protein increased seed content accordingly. Similar results were reported by Chandan *et al.* (2018). Increasing levels of nitrogen from 40 to 120 kg N ha^{-1} increased the oil content in mustard seeds and maximum value of oil content (39.3%) was accrued with 120 kg N ha^{-1}. (Chandan *et al.* (2018) and Mandeewal *et al.* (2022). Protein content in mustard seeds increased from 19.6% at control to 23.0% with 60 kg P_2O_5 ha^{-1} (Table 2). Similar results were recorded by Solanki et al, (2017). The oil content also increased up to 60 kg P_2O_5 ha^{-1} over control. This increase in seed oil content may be attributed to formation of more lecithin with favourable supply of P through external additions. These results corroborate with the findings of Solanki *et al.* (2017) and Ransing *et al.* (2022) in groundnut.

Table 3: Economics of mustard crop (Rs ha^{-1}) as influenced by levels of nitrogen and phosphorus

Treatments	Gross income (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net income (Rs ha^{-1})	B: C ratio
N_1P_0	53010	20015	32995	2.65
N_1P_1	57047	21065	35982	2.71
N_1P_2	60234	22115	38119	2.72
N_1P_3	62801	23165	39636	2.71
N_2P_0	59754	20580	39174	2.90
N_2P_1	63791	21630	42161	2.95
N_2P_2	66978	22680	44298	2.95
N_2P_3	69545	23730	45815	2.93
N_3P_0	63020	21146	41874	2.98
N_3P_1	67057	22196	44861	3.02
N_3P_2	70244	23246	46998	3.02
N_3P_3	72811	24296	48515	3.00

Economics

The regional adaptability of any agronomic practice in the cultivation of any crop is completely based on maximum economic value of treatments. Based on the cost analysis (Table 3), highest net profit of Rs. 48515 ha^{-1} was recorded with 120 Kg N ha^{-1} applied in combination with 60 kg P_2O_5 ha^{-1}. The maximum B:C ratio (3.02) was noted with 120 Kg N ha^{-1} applied in combination with 20 kg P_2O_5 ha^{-1} and 40 kg P_2O_5 ha^{-1}. Additional benefit with each rupee invested in these cases is due to less investment.

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