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Response of Indian mustard (*Brassica juncea*) to nitrogen and phosphorus on Torripsamments of north-western Rajasthan

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A field experiment was conducted during winter (*rabi*) season of 1993–94, 1994–95 and 1995–96 to study the effect of nitrogen (30, 60, 90 and 120 kg N/ha) and phosphorus (0, 15, 30 and 45 kg P_2O_5 kg/ha) on Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Application of N up to 120 kg/ha resulted in significant increase in plant height, primary and secondary branches and siliquae/plant except for seeds/siliqua and 1,000-seed weight up to 90 kg N/ha. Phosphorus application up to 45 kg P_2O_5/ha resulted in significant increase in plant height, secondary branches and siliquae/plant. With the increased supply of P up to 45 kg P_2O_5/ha, the N need of the crop was raised up to 120 kg/ha for significantly higher seed yield (17.05 q/ha). Irrespective of P application, the seed yield increased up to the application of 120 kg N/ha.

Key words : Nitrogen, Phosphorus, Seed yield, Sandy soil, Indian mustard

Indian mustard can be grown under wide range of agro-climatic conditions with varying agronomic management practices. Brassicas respond to N and P nutrients positively in terms of growth and yield (Dhingra *et al.*, 1998; Thakur and Chand, 1998). The light-textured soils of North-Western Rajasthan are deficient in nutrients due to very low organic carbon content. Since information on fertilizer management in mustard on light soils of this region is lacking, the present investigation was undertaken for determining the optimum dose of N and P for Indian mustard crop.

MATERIALS AND METHODS

The study was carried out at Mechanized Agricultural Farm, Rozari, during winter (*rabi*) season of 1993–94, 1994–95 and 1995–96. The soils of the area come under Typic Torripsamments sub-group. The soil of the experimental site was sandy in texture having pH 8.1, ECe 0.2 dS/m, organic matter 0.09%, available phosphorus 24.5 kg P_2O_5/ha and available potassium 275.0 kg K_2O/ha. Sixteen

treatments, comprising 4 levels each of nitrogen (30,60, 90 and 120 kg N/ha) and phosphorus (0,15, 30 and 45 kg P_2O_5/ha), were replicated thrice in factorial randomized block design. Test variety 'Varuna ('T_1 59') of Indian mustard was sown on 4 November, 10 and 30 October during 1993, 1994 and 1995 respectively. Seeds were sown in rows 30 cm apart and thinned 25 days after sowing. Half dose of nitrogen and whole dose of phosphorus were applied basal at sowing and remaining N was top-dressed at pre-flowering stage after the second irrigation. Four irrigations were applied to the crop at intervals of 25–30 days, excluding 1 pre-sowing irrigation, in all the 3 years.

RESULTS AND DISCUSSION

Growth and yield attributes

Plant height at harvest increased significantly with increasing levels of N up to 120 kg/ha. The pooled data (Table 1) revealed that the maximum height was observed under 120 kg N/ha application. Similar trend in plant height was also noted with the graded levels of P application up to 45 kg P_2O_5/ha.

The yield-contributing characters significantly increased with increasing N levels (30–120 kg/ha) (Tables 1 and 2). Application of N up to 120 kg/ha resulted in significantly higher number of primary and secondary branches and siliquae/plant than lower N levels. Both 90 and 120 kg N/ha were at par for seeds/siliqua and 1,000-seed weight. The effect of phosphorus levels was significant on yield attributes except for primary branches/plant, seeds/siliqua and 1,000-seed weight. A trend of increase in secondary branches and siliquae/plant up to 45 kg P_2O_5 level was observed. The results confirm the findings of Tyagi and Rana (1992) and Punia *et al.* (1993).

Interaction effect of N and P was found significant on secondary branches/plant (Table 3). At each P level, there was a significant response to increasing levels of N from 30 to 120 kg/ha for the secondary branches. On the other hand, increasing phosphorus levels up to 45 kg P_2O_5/ha resulted in non-significantly effect on the secondary branches/plant at each N level, except at 120 kg N/ha whereby each successive increase in P level resulted in significantly higher number of secondary branches/plant with the maximum value at 45 kg P_2O_5/ha. This indicates a synergistic effect of phosphorus with the higher levels of N application for better growth and secondary branches.

Seed yield

The seed yield of Indian mustard crop increased significantly with N and P. An increasing level of N up to 120 kg/ha significantly increased the seed yield during all the years (Table 2). Pooled results on seed yield revealed that there was an increase of 42, 97 and 141% with 60, 90 and 120 kg N/ha respectively over the 30 kg N/ha. This might be due to very low organic matter content in the experimental soil. The results confirm the findings of Shukla and Kumar (1994).

An increase in P level up to 45 kg P_2O_5/ha significantly increased seed yield (Table 2). The increase in yield (pooled mean) with 15,30 and 45 kg P_2O_5/ha over the

Table 1. Effect of nitrogen and phosphorus levels on growth and yield attributes of Indian mustard

Treatment	Plant height (cm)				Primary branches/plant				Secondary branches/plant				Siliquae/plant			
	1993–94	1994–95	1995–96	Mean	1993–94	1994–95	1995–96	Mean	1993–94	1994–95	1995–96	Mean	1993–94	1994–95	1995–96	Mean
N (kg/ha)																
30	177.6	176.3	158.0	170.5	3.1	3.1	3.0	3.1	6.3	6.3	5.2	5.9	281	284	224	263
60	180.4	183.5	159.2	174.4	3.3	3.3	3.2	3.3	6.6	6.6	5.3	6.2	303	312	251	289
90	187.1	191.3	160.7	179.7	3.5	3.5	3.2	3.4	9.6	9.4	6.4	8.5	352	359	274	328
120	191.7	197.1	177.2	188.7	3.7	3.7	3.5	3.6	11.2	11.7	9.5	10.8	433	441	291	388
CD (P=0.05)	1.5	0.9	0.7	1.0	0.12	0.14	0.18	0.14	0.17	0.22	0.23	0.20	18.1	16.6	9.5	14.8
P_2O_5 *(kg/ha)*																
0	177.9	182.0	152.9	170.9	3.3	3.3	3.1	3.2	8.1	8.2	6.3	7.5	322	334	250	302
15	183.1	185.8	157.9	175.6	3.4	3.4	3.2	3.3	8.1	8.3	6.6	7.7	335	339	255	310
30	186.4	188.8	167.5	180.9	3.4	3.4	3.2	3.3	8.6	8.6	6.6	7.9	343	347	264	318
45	189.5	191.5	176.8	185.9	3.5	3.5	3.2	3.4	8.9	8.9	6.9	8.2	369	376	269	338
CD (P = 0.05)	1.5	0.9	0.7	1.0	NS	NS	NS	NS	0.17	0.22	0.23	0.20	18.1	16.6	9.5	14.8

NS, Not significnt

Table 2. Effect of nitrogen and phosphorus levels on yield attributes, seed yield and economics of Indian mustard

Treatment	Seeds/siliqua (No.)				1,000-seed weight (g)				Seed yield (q/ha)				Net returns (Rs/ ha)*	Benefit : cost ratio*
	1993–94	1994–95	1995–96	Mean	1993–94	1994–95	1995–96	Mean	1993–94	1994–95	1995–96	Mean		
N (kg/ha)														
30	13.0	13.1	12.1	12.7	3.2	3.2	2.9	3.1	6.58	7.76	5.74	6.69	946	0.21
60	13.6	13.7	12.5	13.3	3.5	3.4	3.1	3.3	9.64	10.51	8.34	9.49	3,269	0.71
90	14.2	13.8	13.2	13.7	3.6	3.6	3.3	3.5	13.48	14.53	11.59	13.20	6,192	1.35
120	14.3	14.4	13.4	14.0	3.8	4.1	3.4	3.8	16.12	17.92	14.34	16.13	8,588	1.87
CD (P=0.05)	0.33	0.49	0.53	0.45	0.42	0.20	0.27	0.31	0.11	0.19	0.27	0.19	159.3	
P_2O_5 *(kg/ha)*														
0	13.6	13.6	12.7	13.3	3.4	3.5	3.1	3.3	10.64	11.70	8.72	10.43	3,857	0.84
15	13.7	13.7	12.8	13.4	3.5	3.6	3.2	3.4	11.15	12.22	9.72	10.95	4,418	0.97
30	13.9	13.8	12.7	13.5	3.6	3.6	3.2	3.4	11.82	13.14	10.36	11.77	5,026	1.10
45	13.9	14.0	12.9	13.6	3.6	3.6	3.2	3.5	12.21	13.65	11.21	12.36	5,509	1.20
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.11	0.19	0.27	0.19	159.3	

NS, Not significant; *Mean data of 3 years

Table 3. Interaction effect of nitrogen and phosphorus levels on yield attributes and seed yield (pooled mean of 3 years) of Indian mustard

N (kg/ha)	(P_2O_5 kg/ha)			
	0	15	30	45
	Secondary branches/plant			
30	5.6	5.9	6.1	6.1
60	6.1	6.1	6.2	6.3
90	8.1	8.2	8.5	8.9
120	10.2	10.4	10.9	11.7
CD (P=0.05)		0.41		
	Seed yield (q/ha)			
30	5.52	6.35	7.31	7.58
60	8.16	8.98	9.99	10.81
90	12.30	13.08	13.47	13.96
120	15.41	15.71	16.33	17.05
CD (P=0.05)		0.38		

control was 5, 13 and 19 % respectively. The response of the crop to P application may be ascribed to the medium level of available P (24.5 kg P_2O_5/ha) in the soil. The results are in agreement with those of Saran and Giri (1990) and Tomar *et al.* (1997).

An interaction effect of N and P on the mustard crop yield was significant (Table 3). The seed yield was significantly higher with 45 kg P_2O_5 and 120 kg N/ha. On the other hand, irrespective of doses of P, mustard crop responded up to 120 kg N/ha. Thus maximum seed yield (17.05 q/ha) of Indian mustard was harvestable with the combined application of 120 kg N and 45 kg P_2O_5/ha on sandy soils under the irrigated conditions.

Economics

The maximum net returns were obtained from 120 kg N/ha. The benefit : cost ratio was also highest with 120 kg N/ha. Similarly, the highest net returns with benefit : cost ratio of 1.20 were obtained with 45 kg P_2O_5/ha.

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