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Response of Ethiopian mustard (*Brassica carinata*) to nitrogen and spacing under rainfed conditions

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Abstract

An experiment was conducted during *rabi* seasons of 2001-2002 and 2002-2003 to workout the response of newly introduced *Brassica carinata* cv. 'JTC 1' to nitrogen and spacing in silty clay loam soil under rainfed conditions. Application of 90 kg N/ha and inter row spacing of 45 cm significantly increased yield attributes and seed yield. The increase in seed yield at 90 kg N/ha application over 0, 30 and 60 kg N/ha was 95.1, 49.1 and 14.7 per cent, respectively. Inter row spacing of 45 cm gave 26.5 and 12.1% higher yield over 30 and 60 cm inter row spacing. Based on response equation optimum dose of N for Ethiopian mustard cv. 'JTC 1' was 87.8 kg/ha.The N uptake and protein content was highest at 90 kg N/ha application and 45 cm inter row spacing. Application of 90 kg N/ha and sowing at 45 cm spacing produced significantly highest seed yield of 31.4q/ha and net returns of Rs 40,298/ha.

Key words: Ethiopian mustard, nitrogen, spacing, rainfed.

In rainfed areas of North Western Himalayas sowing of *rabi* season crop depends on winter rains and residual soil moisture. In last few years rains are almost negligible during October-December. In this situation crop sowing has either to be done in residual moisture or late in season. Among *Brassicas* there are wide variations in growth and maturity resulting in differential response to nutrients, row arrangement and sowing time. Ethiopian mustard (*Brassica carinata*) a thermo and photosensitive, long duration, comparatively less shattering and aphid tolerant crop can fit well under residual moisture sowing conditions. The other advantage is being of tropical origin it can withstand high temperature and water stress in late growing period of February and March which has become a serious concern in north India. Since *Brassica carinata* is a recent introduction in Himachal Pradesh, information on the nitrogen requirement and spacing is meager. Hence, the present study was undertaken to workout the response of newly introduced *Brassica carinata* variety to nitrogen and spacing in silty clay loam soil under low (10-20%) probability of winter rainfall.

Material and Methods

A field experiment was conducted during *rabi* seasons of 2001-2002 and 2002-2003 at Oilseeds Research Station, Kangra. The soil was silty clay loam having pH 6.2, available nitrogen, phosphorus and potassium of 272.5, 12.4 and 210.6 kg/ha, respectively. The treatments which consisted of 5 levels of nitrogen (0, 30, 60, 90, and 120 kg/ha) in main plot and 3 inter row spacing (30, 45 and 60 cm) in sub plot were laid out in split plot design with three replications. Full dose of phosphorus (60 kg P_2O_5/ha) and potassium (40 kg K_2O/ha) were applied at the time of sowing. In treatments where 30 and 60 kg N/ha was to be applied it was applied as basal only whereas in 90 and 120 kgN/ha treatments 60 kg N/ha was applied as basal and remaining at receipt of rains in last week of January. The crop was sown on 4 and 10 October during 2001 and 2002 after harvest of maize crop in residual moisture. Ethiopian mustard variety 'JTC1' was used. All the crop protection measures and weeding operations were followed as per requirement. The rainfall received during *rabi* season 2001-2002 and 2002-2003 was 259.7 mm and 381.6 mm and out of this total rains 54.7 and 88.4% rains, respectively were received during January-March with almost no rains in October-December. Two year data were pooled for analysis.

Results and Discussion

Yield attributes and yield

Growth and yield attributes were significantly influenced by levels of nitrogen and inter row spacing (Table1). The number of primary and secondary branches per plant, number of siliqua per plant , number of seeds per pod and 1000-seed weight increased with increase in nitrogen application upto 90 kg N/ha. The values of these attributes were significantly higher at 45 cm inter row spacing compared to 30 and 60 cm spacing. Seed yield increased with increase in

nitrogen level from 0 to 90 kg N/ha. Further increase upto 120 kg N/ha gave yield at par with 90 kg N/ha. The per cent increase in seed yield with 30, 60, 90 and 120 kg N/ha was 30.8, 70.1, 95.1 and 91.4 over control, respectively. Response of *Brassica carinata* to 100 kg N/ha have been reported by *Kumar et al.* (2002). Increase in inter row spacing from 30 to 45 cm significantly increased the seed yield by 26.5% whereas further increase in inter row spacing from 45 to 60 cm decreased the yield by 10.8 per cent. Significant increase in secondary branches and siliqua per plant at inter row spacing of 45 cm was responsible for increase in seed yield whereas at spacing of 60 cm although yield attributes were higher but they could not compensate the decrease in plant population.

At all the levels of nitrogen application, sowing at 45 cm inter row spacing gave the highest seed yield whereas with further increase in spacing the seed yield decreased (Table 2). The seed yield increased by 10.9-39.6% with increase in inter row spacing from 30 cm to 45 cm. Significantly highest seed yield of 31.4q/ha was produced when 90 kg N/ha was applied and sowing was done at 45 cm inter row spacing. This was followed by seed yield (30.4q/ha) produced at 120 kg N/ha and 45 cm inter row spacing. Oil content was neither effected by rate of N application nor by the inter row spacing followed. As oil yield is product of oil content and seed yield hence the oil yield obtained followed almost same trend as seed yield. Significantly higher yield of oil was obtained at 90 kg N/ha and 45 cm inter row spacing as compared to remaining treatments. Increasing nitrogen rates increase the proportion of protenaceous substances more in seed contributing towards oil yield increase (Kumar, 1992).

Table 1. Influence of nitrogen levels and spacing on the yield attributes, seed yield and economics of *Brassica carinata*

Treatment	Primary branches/ plant	Secondary Branches/ plant	No of siliqua/ plant	No of seeds / pod	1,000 seed weight(g)	Seed yield (q/ha)	Net returns (Rs/ha)	B:C ratio
Nitrogen level (kg/ha)								
0	14.0	14.9	318	9.7	3.14	14.1	12,572	1.18
30	15.1	18.8	380	10.2	3.39	18.5	19,440	1.77
60	16.8	26.1	417	11.2	3.81	24.0	28,325	2.52
90	17.4	30.7	556	11.3	3.94	27.6	33,874	2.94
120	17.5	28.8	506	11.1	3.99	27.1	32,550	2.76
SEm±	0.1	0.2	1.9	0.1	0.02	0.4		
CD(P=0.05)	0.4	0.8	6.4	0.2	0.05	1.2		
Row Spacing (cm)								
30	15.3	21.5	386	8.8	3.40	19.7	20,744	1.77
45	16.2	25.4	467	11.8	3.84	24.9	29,776	2.63
60	16.9	24.7	453	11.6	3.72	22.2	25,536	2.30
SEm±	0.1	0.1	4.9	0.06	0.02	0.2		
CD(P=0.05)	0.3	0.3	14.6	0.17	0.07	0.5		

Table 2. Interaction effect of nitrogen levels and spacing on seed yield of *Brassica carinata* under rainfed condition

Treatments	Seed yield (q/ha)		
	30 cm	45 cm	60 cm
N_0	12.8 (9937)	15.1 (14215)	14.5 (13565)
N_{30}	17.4 (17402)	19.3 (20956)	18.7 (19962)
N_{60}	20.2 (21502)	28.2 (35305)	23.7 (28167)
N_{90}	24.5 (28632)	31.4 (40298)	26.7 (32692)
N_{120}	23.4 (26249)	30.4 (38107)	27.3 (33293)

Seed yield SEm±: 0.678 CD (P=0.05): 1.506
Values in parenthesis are net returns Rs/ha

Increase in oil yield with increase in nitrogen application upto 100 kg N/ha have been reported by Kumar *et al.* (2002).

Response function

The response of nitrogen on yield of *Brassica carinata* worked out by fitting response equation from seed yield data pooled over years,

$$Y = 14.79 + 0.1604X - 0.0004X^2$$

The response to nitrogen was quadratic and optimum dose of nitrogen worked out to be 87.8 kg N/ha with corresponding yield of 25.79 q/ha. The response to per kg nitrogen at optimum dose in term of seed yield turned out to be 13.2 kg/kg of N.

Economics

The net returns and benefit: cost ratio increased with increase in N level from 30 to 90 kg N/ha with highest values (Rs 36,198 and 2.94) at 90 kg N/ha (Table1). Further increase in N level to 120 kg N/ha (Rs 35,240 and 2.76) decreased the net return compared to 90 kg N/ha but it was higher than 60 kg N/ha application (Rs. 29,958 and 2.52). Among inter row spacing maximum return and benefit: cost ratio was obtained at 45 cm spacing (Rs 34,247 and 2.63) and this was Rs. 13,552 and Rs. 9,230 higher than the sowing at 30 and 60 cm inter row spacing, respectively. Significantly highest net returns of Rs 40,298/ha were obtained when 90 kg N/ha was applied at 45 cm inter row spacing and was followed by returns of Rs 38,107/ha obtained with 120 kg N/ha at 45 cm spacing (Table 2).

Nutrient uptake and soil N status

The nutrient N uptake by seed, straw and total N uptake by crop increased significantly with increase in N level application from 0 to 120 kg N/ha (Table3).

However the uptake at 90 and 120 kg N/ha was statistically at par. The per cent increase in N uptake at 30, 60, 90 and 120 kg N/ha application was 55.1, 125.2, 211.1 and 215.8 over control, respectively. Increase in root exchange capacity with nitrogen application is known to enhance the nitrogen absorption (Pramanik *et al.*, 1996). The N uptake was significantly highest at 45 cm inter row spacing and further increase in spacing resulted in decline in uptake. This higher uptake at increasing level was related to increase in availability of N and at inter row spacing of 45 cm plants got the best opportunity to harness the growth advantage which was also reflected on yield increase.

Protein being amino acids with nitrogen as a main constituent and as the N uptake increases the protein content also increases (Kumar, 1992). The protein content was higher at 90 kg N/ha and at 45 cm spacing. Increase in protein content with increase in spacing may be ascribed to increase in N content in seeds due to better growth harnessing the nutrient resource efficiently. Similar results have been reported by Rana *et al.* (1991).

The available N content in soil at harvest of crop was highest at 120 kg N/ha application (Table 3). However the available N content at 90 kg N/ha application was also statistically at par. There was decline in available N content at 0 and 30 kg N/ha application whereas at 60 to 120 kg N/ha application there was buildup of N. The buildup was partly attributed to the biomass added as leaf fall (5-6 q/ha) which on mineralization added to the soil pool.

Hence it can be concluded that in silty clay loam soils under rainfed condition maximum yield (31.4 q/ha) and net returns (Rs 40,298) of Ethiopian mustard can be obtained with application of 90 kg N/ha and sowing at 45 cm inter row spacing.

Table 3. Influence of nitrogen level and spacing on quality parameter and N uptake by *B. carinata* and available nitrogen in soil at harvest

Treatment	% Oil content	Oil yield (kg/ha)	Nitrogen uptake(kg/ha)			Protein content (%)	Available nitrogen (kg/ha)
			Seed	Straw	Total		
Nitrogen level(kg/ha)							
0	43.9	620.6	9.3	14.3	23.7	8.3	242
30	44.3	818.4	16.1	20.6	36.7	10.9	260
60	43.9	1057.8	25.4	27.9	53.3	12.6	312
90	44.0	1210.4	35.8	37.8	73.6	15.4	326
120	43.6	1181.6	35.9	38.8	74.7	15.6	338
SEm±	0.20	17.1	0.48	.54	0.86	0.32	2.8
CD(P=0.05)	NS	55.8	1.57	1.77	2.82	1.04	10.39
Row Spacing (cm)							
30	43.9	863.3	18.6	20.7	39.3	11.8	281
45	43.9	1093.5	30.2	33.2	63.4	12.6	294
60	44.1	976.3	24.7	29.1	53.8	13.8	313
SEm±	0.10	7.78	0.64	0.62	0.92	0.38	3.6
CD(P=0.05)	NS	22.9	1.84	1.79	2.62	1.12	13.52

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