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Response of mustard (*Brassica juncea*) to nitrogen and sulphur under dryland conditions

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ABSTRACT

A field experiment was conducted during winter seasons of 2000–2001 and 2001–2002 to study the response of Indian mustard [*Brassica juncea* (L.) Czernj & Cosson] cv. 'Pusa Barani' to nitrogen and sulphur levels. Application of 60 kg N/ha and 40 kg S/ha significantly increased the seed yield with concomitant increase in yield attributes. The per cent increase in seed yield at 60 kg N/ha over 40, 20 and the control was 12.6, 23.8 and 79.8 and at 40 kg S/ha over 20 and control was 12.7 and 32.5 respectively. Each higher level of nitrogen and sulphur appreciably improved the growth and yield attributes (branches/plant, siliquae/plant, seed yield/plant, 1,000-seed weight and harvest index. The seed yield response to tested levels of N and S was found quadratic. Based on response equation optimum dose of N and S for Indian mustard cv. 'Pusa Barani' was found to be 70.8 and 51 kg/ha, respectively. The uptake of N and S increased sign icantly up to 80 and 40 kg N/ha, respectively, while sulphur application resulted in marked increase in N and S uptake only up to 40 kg S/ha. Maximum net returns/ha was recorded with 80 kg N (Rs 10,538/ha) and 60 kg S/ha (Rs 9,176/ha).

Key words : Mustard, Nitrogen, Sulphur, Dryland, Seed yield

Indian mustard is an important winter (*rabi*) season oilseed crop of dryland of north-western parts of India. In this part amount of soil moisture available to crop vary with the soil type (soil tex ure and depth) and variable probability of winter rai all under different agro-climatic conditions resulting in variable respons of the crop to applied plant nutrients under dryland conditions. So the optimum dose of plant nutrients under dryland conditions vary with moisture availability. Among the plant nutrients, nitrogen and sulphur are the most important for increasing the productivity of Indian mustard, particularly in soil low in available nitrogen and sulphur (Kachroo and Kumar, 1997; Rana *et al.* 2001). An information on the nitrogen and sulphur need of this crop is still inadequate for deep sandy loam soil having adequate soil moisture storage and high probability of rainfall during the crop season. Therefore, present study was undertaken to ascertain the response of Indian mustard to N and S in deep sandy loam soil analyzing low in nitrogen and sulphur and receiving on an average 16 per cent of the average annual rainfall (680 mm) during winter season.

MATERIALS AND METHODS

A field experiment was conducted during the winter (*rabi*) seasons of 2000–2001 and 2001–2002 at New Delhi on sandy loam soil with pH 7.4 and analyzing low in organic carbon (0.4%) and available S (7.2 ppm) and medium in available P (14.0 kg/ha) and K (221 kg/ha). The treatment combinations of 5 levels of nitrogen (0, 20, 40, 60 and 80 kg N/ha) and 4 levels of sulphur (0, 20, 40 and 60 kg S/ha) were tested in a 3 times replicated radomized block design. As per treatment, full dose of N as urea and S as gypsum along with 20 kg P_2O_5/ha were applied before sowing by drilling in furrows. The crop was sown after fallow conserved soil moisture. Indian mustard cv. 'Pusa Barani' was sown in rows 50 cm apart on 26 and 28 October and harvested on 24 and 30 March during 2000–2001 and 2001–2002 respectively. The crop received one hand weeding at 35 days after sowing and one spray of insecticide + fungi de in the first week of January. The plant stand was optimum during the crop season. The crop received 170 and 180 mm rainfall during 2000–2001 and 2001–2002, respectively.

RESULT AND DISCUSSION

Growth and yield attributes

Nitrogen and sulphur application induced signific nt increase in the growth and yield attributes of Indian mustard (Table 1). Nitrogen application up to 60 kg N/ha recorded significant increase in number of branches/plant, siliquae/plant, seeds/siliqua, 1000-seed weight and seed yield/plant over subsequent level of nitrogen. Nitrogen

application beyond 60 kg N/ha caused improvement in most of growth and yield attributes but increase was statistically insignificant. Contrary to N, subsequent increase in sulphur level caused marked increase in the aforesaid parameters up to 40 kg S/ha except, 1000-seed weight, where the increase was significant up to 60 kg S/ha. Improvement in the growth and yield attributes of Indian mustard due to N and S application appeared quite logical. It is well known that N and S being the constituents of amino acids, proteins, chlorophyll and protoplast would directly influence plant growth and development through better utilization of photosynthates. Kachroo and Kumar (1997), Singh and Kumar (1996) and Rana *et al.* (2001) also reported increase in growth and yield attributes of rapeseed-mustard due to N and S application.

Seed yield and harvests index

Favourable effects of N and S application on the growth and yield attributes further got reflected on the seed yield and harvest index. The seed yield recorded significant increase up to 60 kg N/ha. Further increase in N level did not produce perceptible increase in seed yield. On pooled basis, the per cent increase in seed yield with 20, 40, 60 and 80 kg N/ha was 38.2, 59.5, 79.8 and 87.2 over control, respectively. Successive increase in sulphur application produced significant increase in seed yield up to 40 kg S/ha. Subsequent increase in the S application from 40 to 60 kg/ha improved the seed yield, however, it was of the same order statistically. The increase in seed yield at 20, 40 and 60 kg S/ha over control was 17.5, 32.5 and 35.8 per cent respectively.

Contrary to seed yield, harvest index recorded significant increase with N application up to 40 kg N/ha. Further increase in N level did not produce perceptible increase in harvest index. Significant effect of sulphur on harvest index was observed only up to 20 kg S/ha, although there was improvement in the harvest index with subsequent increase in S levels. The improvement in the harvest index may be due to better translocation of photosynthates leading to more siliquae/plant, more seeds/siliqua and higher test weight due to N and S application. These results are in conformity with Khanpara *et al.*, (1993) and Rana *et al.*, (2001).

Response function

The response of nitrogen and sulphur on yield of Indian mustard was worked out by fitting response equation and following estimated equation for nitrogen and sulphur were obtained from seed yield data pooled over two years.

Nitrogen : $Y = 9.4518 + 0.2083\ N - 0.0014\ N^2$
Sulphur : $Y = 11.99 + 0.1485\ S - 0.0013\ S^2$

These equations revealed that response to nitrogen and sulphur was quadratic, indicating the operation of the law of diminishing return. As per above equations, the optimum dose of nitrogen and sulphur were worked out to be 70.8 and 51 kg/ha respectively. The corresponding values of optimum yields were 17.18 and 16.18 q/ha respectively. The response per kg of nitrogen and sulphur at optimum dose in terms of seed yield was worked out to be 10.9 and 8.2 kg/kg of N and S, whereas returns on each rupee of investment on these nutrients were Rs 9.91 and 5.33, respectively. The crop responded to higher levels of N and S under dryland conditions due to favourable soil and weather conditions and proper placement of nutrient in the soil profile. The soil of the experimental site was deep

Table 1. Growth and yield attributes, seed yield, harvest index, nutrient uptake and economics of Indian mustard as influenced by nitrogen and sulphur (Data pooled over two years)

Treatment	Branches/ plant	Siliquae/ plant	Seeds/ siliqua	Seed yield/ plant (g)	1000-seed weight (g)	Seed yield (q/ha)	Harvest index (%)	Total nutrient uptake (kg/ha) N	Total nutrient uptake (kg/ha) S	Net returns (Rs/ha)	Benefit : cost ratio
N (kg/ha)											
0	9.7	167.6	10.0	4.20	3.96	9.4	24.15	34.2	15.4	3,138	0.50
20	13.5	198.3	10.5	6.19	4.13	13.0	25.65	52.2	19.6	6,538	1.01
40	16.0	225.7	11.1	8.43	4.27	15.0	26.31	76.4	22.2	8,338	1.25
60	18.2	273.9	11.6	10.63	4.61	16.9	26.76	90.2	24.3	10,038	1.46
80	18.5	286.6	11.6	10.66	4.59	17.6	26.10	97.3	25.3	10,538	1.49
CD (P=0.05)	0.8	22.6	0.29	0.64	0.15	1.8	0.67	5.1	2.5		
S (kg/ha)											
0	12.5	198.2	10.5	6.33	4.13	12.0	25.04	56.2	13.9	5,800	0.93
20	13.9	225.1	10.8	7.65	4.21	14.1	25.90	69.2	20.2	7,592	1.16
40	16.1	248.5	11.1	9.08	4.46	15.9	26.10	78.6	24.7	9,084	1.33
60	16.7	256.2	11.2	9.16	4.68	16.3	26.12	81.3	26.6	9,176	1.28
CD (P=0.05)	0.7	21.4	0.26	0.43	0.11	1.7	0.45	4.8	2.3		

sandy loam having sufficient capacity to store conserved moisture. In addition to this, the crop received good amount of rainfall during both the crop seasons (170 and 185 mm during 2000–2001 and 2001–2002, respectively), which ensures proper utilization of the applied nutrients for proper growth and development of the crop and finally higher seed yield.

Economics

The cost of cultivation varied according to different doses of nitrogen and sulphur. The maximum net returns (Rs 10,538/ha) and benefit : cost ratio (1.49) were obtained with 80 kg N/ha. Benefit : cost ratio recorded continuous increase with increasing level of N but the maximum increase was recorded between 0 and 20 kg N/ha. In case of sulphur, maximum net returns (Rs 9,176/ha) was recorded with 60 kg S/ha, whereas the highest benefit : cost ratio was recorded with 40 kg S/ha (Table 1). This behaviour of net returns and benefit : cost ratio may be attributed to yield trend due to N and S application and relative cost of inputs in relation to output.

Nutrient uptake

There was a significant increase in the total N and S uptake due to application of N and S. The N uptake increased significantly with subsequent increase in N application up to 80 kg N/ha, while significant increase in S uptake due to N application was noted only up to 40 kg N/ha. Sulphur application caused significant increase in N and S uptake only up to 40 kg S/ha. The increase in N and S uptake due to N and S application could be ascribed to variation in the availability of these nutrients in the soil, their priming effect on each other and their role in the growth and development of the plant.

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