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Response of Indian mustard (*Brassica juncea*) to irrigation and fertilization with various sources and levels of sulphur

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ABSTRACT

A field investigation was carried out with Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] cv. 'RH 30' during the winter season of 1995–96 and 1996–97 with 2 irrigation treatments and 2 sources (gypsum and single superphosphate) and 3 levels (0, 30 and 60 kg S/ha) of fertilizer S. Irrigation applied at branching, flowering and grain-filling stages significantly increased seed yield of Indian mustard over that at pre-flowering, pod-formation and grain-filling stages. Gypsum proved to be better source of S than single superphosphate, as the former gave significantly higher seed yield and net profit. Increase in the S levels significantly improved growth, yield attributes, seed yield and oil content of Indian mustard. The highest seed yield, oil content and net returns were obtained with 60 kg S/ha.

Key words : Indian mustard, Sulphur sources and levels, Single superphosphate, Gypsum, Yield, Net income

Indian mustard is an important oilseed crop of India, which is responsive to irrigation and fertilization. In recent years, S deficiency in coarse-textured soils has been observed which may chiefly be attributed to increased removal of S by adoption of high-yielding fertilizer-responsive varieties, intensive cultivation and extensive use of high-analysis fertilizers. Therefore, in order to harness full potential of the high-yielding varieties of Indian mustard, fertilizer S must form a part of the integrated nutrient management programme.

Very limited information is available on sulphur nutrition of mustard. Among various sources of fertilizer S, gypsum and single superphosphate (SSP) are superior to the other sources in increasing the yield potential of oilseeds grown in coarse-textured soils (Singh and Sahu, 1986). Moreover, these sources are easily available to the farmers in India. But the comparative performance of these 2 sources has not been studied properly in S-deficient, coarse-textured soils of south Haryana where Indian mustard is grown extensively. There are reasons of economy too in evaluating and finally recommending a

particular S source for the crop production. Therefore, the present investigation was undertaken to find out the better source and optimum dose of fertilizer S for Indian mustard grown on these soils under irrigated conditions.

MATERIALS AND METHODS

The field investigation was carried out at Regional Research Station, Gurgaon, during the winter season of 1995–96 and 1996–97 on sandy-loam soil, alkaline in reaction (pH 8.5), low in available N (171 kg N/ha), medium in available phosphorus (16 kg P/ha) and high in potash (356 kg K/ha). The sulphate-sulphur level of the soil was 4.2 ppm, which was low for the Indian mustard crop. The treatments consisted of 2 irrigation schedules, 2 sources of fertilizer S (gypsum and SSP) and 3 levels of fertilizer S (0, 30 and 60 kg S/ha). The irrigation was scheduled, at 40 (branching), 70 (flowering) and 110 (grain-filling) days or at 50 (pre-flowering), 80 (pod formation) and 120 (grain-filling) days after sowing. The treatments were laid out in split-plot design, keeping the irrigation treatments and sources of S in main plots and levels of S in subplots.

Indian mustard cv. 'RH 30' was sown in the last week of October during both the years on flat beds in plots of size 5 m × 2.4 m in rows 30 cm apart using 6 kg seed/ha. The crop was supplied with 60 kg N/ha and at least 40 kg P_2O_5/ha, the recommended doses. In control (no S) and gypsum-treated plots, P was supplied through diammonium phosphate (DAP), whereas in single superphosphate (SSP) treated plots, the SSP itself served as the source of P. The N was supplied through urea (after adjusting the N supplied through DAP wherever necessary). Half dose of N and full dose of P_2O_5 and S were applied as basal dose at sowing, whereas the remaining N (through urea) was top-dressed after the first irrigation. Economics of the crop was worked out considering the cost of various operations, inputs, commodity and labour charges based on prevalent market prices.

RESULTS AND DISCUSSION

Irrigation

The irrigation given at branching, flowering and grain-filling stages was found better, as it recorded significantly higher siliquae/plant (Table 1), yield (q/ha) of both seed and oil and consequently higher net profit (Table 2) than the irrigation applied at pre-flowering, pod-formation and grain-filling stages. Supply of water at flowering might have resulted in lengthening of the flowering period, which increased the number of siliquae (Clark and Simpson, 1978) and consequently the seed yield. Dastane *et al.* (1971) also reported that irrigation at flowering in Indian mustard was significantly superior to that at pod-formation stage.

Sources of sulphur

Gypsum was found to be a better source of S as number of primary branches, 1,000-seed weight and seed yield were significantly higher with gypsum compared to that with SSP. The seed yield obtained with gypsum was 8.8 and 7.9% higher than that with SSP during 1995–96 and 1996–97 respectively. The superiority of gypsum is attributable to the fact that gypsum lowers

Table 1. Growth and yield attributes of Indian mustard as influenced by irrigation schedule and sulphur fertilization

Treatment	Plant height (cm)		Primary branches/ plant		Siliqua length (cm)		Siliquae/ plant		Seeds/ siliqua		1,000-seed weight (g)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Irrigation schedule												
40, 70, 110 DAS	203.6	188.4	6.41	6.28	5.08	5.32	223.8	238.9	13.51	12.84	6.91	6.39
50, 80, 120 DAS	206.4	184.1	6.31	6.31	5.05	5.41	208.2	226.1	13.20	12.60	6.71	6.30
CD (P=0.05)	NS	NS	NS	NS	NS	NS	4.5	6.4	NS	NS	NS	NS
Sources of S												
Gypsum	203.4	187.6	6.50	6.46	5.07	5.41	215.3	231.3	13.53	12.90	7.03	6.53
SSP	206.6	184.9	6.22	6.13	5.06	5.31	216.7	233.7	13.18	12.54	6.59	6.17
CD (P=0.05)	NS	NS	0.12	0.15	NS	NS	NS	NS	NS	NS	0.42	0.24
Levels of S (kg/ha)												
0	201.8	179.2	6.07	5.89	4.97	5.25	205.6	219.8	13.40	12.67	6.46	6.04
30	206.5	188.1	6.46	6.44	5.09	5.38	218.2	234.4	13.35	12.67	6.78	6.35
60	206.6	191.6	6.56	6.55	5.12	5.46	224.2	243.3	13.31	12.83	7.19	6.65
CD (P=0.05)	4.3	3.6	0.18	0.13	0.11	0.13	5.6	6.7	NS	NS	0.40	0.29

NS, Not significant; DAS, days after sowing

soil pH (Yadav *et al.*, 1991) which might have improved the availability of other nutrients to the plants besides improving physical and chemical properties of the soil by replacing Na with Ca in the exchange complex. Sharma *et al.* (1991) also reported similar findings. Gypsum gave an additional profit of Rs 2,325/ha over SSP when averaged over the irrigation and S levels, which is mainly owing to higher yield of Indian mustard obtained with gypsum.

Levels of sulphur

Application of sulphur at 30 kg S/ha significantly increased plant height, number of primary branches, siliqua length, number of siliquae/plant, 1,000-seed weight, seed yield, oil content and net income of Indian mustard over the control (Table 1). Increase in S level from 30 to 60 kg/ha further increased the number of siliquae, 1,000-seed weight, seed yield, oil content and the net return. Based on average of the 2 years, the magnitude of increase at 60 kg S/ha compared with 0 and 30 kg S/ha, respectively, was 19.3 and 7.5% in case of seed yield. The increase in yield owing to S application is imminent, as the crop has higher S requirement (Aulakh *et al.*, 1985) and the soil was deficient in available S. Oil yield was associated with the seed yield and oil content. The results are in close conformity to that of Singh and Kumar (1996). An additional income of Rs 2,550 and Rs 4,131 was obtained with the application of 30 and 60 kg S/ha, respectively, over the control. Therefore, an

Table 2. Seed yield, oil content, oil yield and economics of production (based on the average of the 2 years) of Indian mustard as influenced by irrigation schedule and sulphur fertilization

Treatment	Seed yield (q/ha)		Oil content (%)		Oil yield (q/ha)		Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97			
Irrigation schedule									
40, 70, 110 DAS	19.20	18.54	38.57	39.60	7.42	7.14	12,063	24,531	12,468
50, 80, 120 DAS	17.72	17.51	38.79	39.84	6.88	7.32	12,063	22,893	10,830
CD (P=0.05)	0.50	0.53	NS	NS	0.20	0.22			
Sources of S									
Gypsum	19.24	18.75	38.65	39.64	7.45	7.24	11,876	24,687	12,811
SSP	17.69	17.29	38.69	39.81	6.85	7.04	12,251	22,737	10,486
CD (P=0.05)	0.50	0.53	NS	NS	0.20	0.18			
Levels of S (kg/ha)									
0	16.80	16.24	37.78	38.93	6.34	6.33	12,054	21,476	9,422
30	18.54	18.15	38.40	39.80	7.12	7.23	11,870	23,842	11,972
60	20.05	19.67	39.84	40.53	7.99	7.86	12,265	25,818	13,553
CD (P=0.05)	0.48	0.69	0.32	0.31	0.16	0.23			

DAS, Days after sowing

application of 60 kg S/ha preferable through gypsum may be suggested for higher yield, oil content and net income of Indian mustard grown on coarse-textured soils of south Haryana under irrigated conditions.

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