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Response of Indian mustard (*Brassica juncea*) to source and level of sulphur

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ABSTRACT

Three Indian mustard [*Brassica juncea* (L.) Czernj. & Crosson] cultivars ('Varuna', 'Vardan' and 'Narendra Rai 1,) with 3 sulphur sources (gypsum, elemental sulphur and pyrite) and 4 sulphur levels (0, 20, 40 and 60 kg/ha) were tested during the winter (*rabi*) season of 1996–97 and 1997–98. 'Narendra Rai 1' and 'Varuna' gave higher plant height, branches/plant, siliquae/plant, seeds/siliqua, 1,000-grain weight and harvest index and resulted significantly higher seed and stover yields, sulphur uptake, oil and protein contents than 'Vardan', though the former two were at par during both the years. However, the sources of sulphur did not influence the growth yield attributes and yields as well as quality of Indian mustard. The application of 40 and 60 kg S/ha being at par with each other gave significantly higher yield and quality (protein and oil contents in seed) over 20 kg and no-sulphur application. The growth and yield-attributing characters showed also similar trend. On the basis of economics, 'Narendra Rai 1' fertilized with 40 kg S/ha either through gypsum or pyrite was found most profitable.

Key words : Indian mustard, Sulphur, Yield, Economics

Indian mustard [*Brassica juncea* (L.) Czernj. & Crosson] is one of the important oilseed crops grown intensively in Uttar Pradesh. The high-yielding variety has been reported to be highly responsive to sulphur application. During the past few years, sulphur has received increasing attention. Global reports of sulphur deficiency and consequent crop responses are quite ostensible (Tandon, 1989). Keeping this in view, the present study was undertaken to evaluate the response of Indian mustard cultivars to different resources and levels of sulphur.

MATERIALS AND METHODS

A field study was conducted at Kumarganj, Faizabad, during the winter (*rabi*) season of 1996–97 and 1997–98. The

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soil was silty loam with pH 7.9 and contained 0.44% organic carbon and 179.4 kg/ha available N, 15.7 kg/ha available P, 258.4 kg/ha available K and 8.3 kg/ha available S. The experiment was conducted in split-plot design replicated thrice, keeping 3 varieties ('Varuna', 'Vardan' and 'Narendra Rai 1') in main plots and combination of 3 sulphur sources (gypsum, elemental sulphur and pyrite) and 4 levels of sulphur (0, 20, 40 and 60 kg/ha) in subplots. Half dose of nitrogen (40 kg/ha) and full dose of phosphorus and potash each 40 kg/ha was applied basal and remaining half dose of N (40 kg/ha) was applied after the first irrigation. Sulphur was applied in various forms as per treatment before sowing.

RESULTS AND DISCUSSION

Effect of varieties

Among Indian mustard varieties, 'Narendra Rai 1' and 'Varuna' gave significantly higher seed yield, respectively, than 'Vardan' owing to better expression of siliquae/plant, seeds/siliqua, 1,000-grain weight, harvest index and stover yield, and consequently gave higher net returns and net returns/Reinvestment (Rs 11073/ha and 0.91). The other growth parameters such as plant height and primary and secondary branches/plant showed in similar trends (Tables 1 and 2). 'Narendra Rai 1' recorded significantly higher uptake of sulphur than 'Vardan' and 'Varuna' during both the years but 'Varuna' was found superior in

Table 1. Effect of sources and levels of sulphur on growth and yield-contributing characters of various varieties of Indian mustard (mean data of 2 years)

Treatment	Plant height (cm)	Branches/plant Primary	Branches/plant Secondary	Siliquae/ plant	Seeds/ siliqua	1,000-grain weight (g)	Harvest index (%)
Variety							
'Varuna'	180.8	6.1	13.6	304.4	13.9	5.0	24.3
'Vardan'	170.0	5.5	10.6	262.9	12.1	41	23.6
'Narendra Rai 1'	183.2	6.3	13.8	311.3	14.5	5.2	24.5
CD (P=0.05)	8.4	0.4	0.9	20.7	0.9	0.4	
Sources of sulhur							
Gypsum	178.7	6.0	12.7	294.0	13.7	4.8	24.2
Elemental S	177.2	5.8	12.6	289.9	13.3	4.6	24.1
Pyrite	178.1	5.9	12.6	292.2	13.8	4.7	24.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	
Sulphur (kg/ha)							
0	147.7	4.9	10.2	241.1	11.1	3.9	23.8
20	171.2	5.6	12.0	274.9	12.9	4.4	24.1
40	179.9	6.1	12.9	297.6	13.8	4.9	24.3
60	182.9	6.2	13.1	303.6	14.1	4.9	24.3
CD (P=0.05)	5.7	0.3	0.7	9.5	0.7	0.3	

Table 2. Effect of sources and levels of sulphur on yield and economics on varieties of Indian mustard

Treatment	Seed yield (q/ha)			Stover yield (q/ha)			Net return (Rs/ha)	Net return/ Re-investment (Rs)
	1996–97	1997-98	Mean	1996–97	1997-98	Mean		
Variety								
'Varuna'	20.7	19.4	20.1	63.5	61.5	62.5	9,588	0.87
'Vardan'	18.1	17.0	17.6	57.7	56.0	56.9	7,006	0.64
'Narendra Rai 1'	21.0	20.0	20.5	63.7	62.3	63.0	11,073	0.91
CD (P=0.05)	1.2	1.2	1.2	4.1	3.7	3.9		
Sources of sulhur								
Gypsum	20.0	18.9	19.5	61.8	60.0	60.9	9,749	0.92
Elemental S	19.9	18.8	19.4	61.5	59.9	60.7	7,608	0.61
Pyrite	19.9	18.8	19.4	61.6	59.9	60.8	9,754	0.93
CD (P=0.05)	NS	NS	NS	NS	NS	NS		
Sulphur (kg/ha)								
0	17.1	16.2	16.7	53.7	53.7	53.7	7,113	0.69
20	19.1	18.0	18.6	59.8	57.6	58.7	8,664	0.81
40	20.3	19.2	19.8	62.3	60.6	61.5	9,330	0.85
60	20.4	19.3	19.9	62.5	61.0	61.8	9,116	0.81
CD (P=0.05)	0.8	1.0	0.9	1.1	2.2	1.7		

oil content as well as protein contents which was significantly superior to 'Vardan' and 'Narendra Rai 1' (Table 3). Which may be due to genetic characters of the various varieties.

Effect of sources of sulphur

Application of sulphur in Indian mustard through gypsum, elemental sulphur and pyrite was found equally effective for plant height, branches/plant, siliquae/plant, seeds/siliqua, 1,000-seed weight and harvest index. The variation in seed and stover yields due to various sources of sulphur was also found non-significant, but net returns and net returns/Re invested were maximum in case of pyrite application and minimum in case of elemental sulphur application (Tables 1 and 2). Sulphur uptake, protein and oil contents were also not affected due to various sources of sulphur (Table 3). This might be due to similar effect of various sources of sulphur. Similar results were also obtained by Rajput *et al.* (1993).

Effect of sulphur levels

The plant height, branches/plant, siliquae/plant, seeds/siliqua, 1,000-grain weight and harvest index significantly increased with increasing levels of sulphur up to 40 kg/ha (Table 1). There was no significant difference between 40 and 60 kg S/ha. The results are in agreement with the findings obtained by Singh and Kumar (1996).

The increase in mean seed yield with 40 kg S/ha was 6.45 and 18.56% and in stover yield 4.77 and 14.53% over 20 kg and no

Table 3. Effect of sources and levels of sulphur on sulphur, protein content (%) and oil content (%) varieties of Indian mustard

Treatment	Sulphur uptake (kg/ha)		Protein content (%)		Oil content (%)	
	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98
Variety						
'Varuna'	13.9	12.6	22.3	21.1	42.4	40.8
'Vardan'	11.4	10.6	18.1	16.4	40.3	37.9
'Narendra Rai 1'	14.1	13.1	21.2	18.6	42.0	39.4
CD (P=0.05)	0.6	0.5	1.0	1.3	0.4	0.6
Sources of sulhur						
Gypsum	13.2	12.3	20.8	18.5	41.6	39.4
Elemental S	13.0	11.9	20.3	18.2	41.4	39.3
Pyrite	13.1	12.1	20.5	18.4	41.6	39.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Sulphur (kg/ha)						
0	10.3	9.7	17.3	15.9	37.9	36.3
20	12.3	11.2	19.3	17.5	40.4	38.2
40	13.4	12.4	20.9	18.6	42.0	39.9
60	13.7	12.8	21.4	19.0	42.3	40.0
CD (P=0.05)	0.5	0.7	1.5	0.6	0.7	0.5

sulphur application respectively (Table 2). The soil low in S status was unable to supply the nutrient sufficiently for optimum growth and yield of the crop. There was no significant difference between 40 and 60 kg S/ha. The increase in seed yield was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application. Net returns increased with increase in S rate up to 40 kg/ha. Thereafter net returns decreased at 60 kg S/ ha. The S application @ 40 kg/ha gave the highest net returns in both the years. The net returns/rupee invested in sulphur fertilizer worked out to Re 0.81, 0.85 and 0.81 due to application of 20, 40 and 60 kg S/ha respectively. The results confirm the findings of Sharma (1994). The optimum economic dose was worked out to be 32.1 kg S/ha and maximum sulphur dose 59.4 kg/ha had shown consequently lower yield of Indian mustard/ha than that produced by 40 kg S/ha.

Uptake of sulphur by seeds and contents of oil and protein in seed were significantly increased with increasing levels of sulphur up to 40 kg S/ha, however, it was found at par with 60 kg S/ha during both the years (Table 3).

The magnitude of increase over control due to application of 40 kg S/ha was 38.2 and 34.3% (uptake) and 10.9 and 9.8% (oil content) in both the years respectively. Increase in oil content was mainly due to an increase in glucoside formulation (Singh and Singh, 1977). Higher sulphur utilization by crop with adequate supply of sulphur which enhance the protein synthesis in plant and ultimately increased the protein content in mustard.

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