

Effect of nitrogen and sulphur on sulphur content in Indian mustard (*Brassica juncea*) and their residual balance in soil

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ABSTRACT

A field experiment was conducted during the winter (*rabi*) seasons of 1988-89 and 1989-90 to study the effect of nitrogen and sulphur on the seed and oil yields, and S content and its uptake by Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Nitrogen up to 90 kg/ha and sulphur up to 30 kg/ha significantly increased the seed and oil yields, S content and its uptake. Nitrogen had adverse effect on oil content. The S concentration was more during early stages of growth up to 45 days after sowing and declined thereafter steadily up to 90 days after sowing. Response to N and S was found linear.

There is an ample scope for increasing the yield of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] through fertilizer use, especially nitrogen and sulphur (Tandon, 1990). The crop of Indian mustard yielding 1,500 kg/ha removes 105, 17, 77 and 31 kg/ha of N, P, K and S respectively (Tandon, 1986). Considering the significance of such investigations and with growing realization of the importance of N and S nutrients in respect of their influence on plant growth and development, seed yield, oil content and oil yield of Indian mustard crop under irrigated Vertisol conditions, the present investigation was undertaken.

MATERIALS AND METHODS

The field experiment was conducted during the winter (*rabi*) seasons of 1988-89 and 1989-90 on clay-loam soil of Powarkheda. The soil had pH 7.2. The

available N, P, S and K contents were respectively 183.7, 13.6, 8.03 and 301.4 kg/ha during 1988-89 and 202.6, 13.4, 7.95 and 333.8 kg/ha during 1989-90. The experiment was laid out in factorial randomized block design with 3 replications during both the years. The treatments consisted of combinations of 4 nitrogen levels (0, 30, 60 and 90 kg/ha) and 6 sulphur levels (0, 10, 20, 30, 40 and 50 kg/ha). Indian mustard 'Varuna' was sown in rows (commonly grown in this area), 30 cm apart using 5 kg seeds/ha on 28 October 1988 and 3 November 1989, and harvested 118 days after sowing. A uniform plant population was maintained by thinning the crop with an intra-row spacing of 15 cm. A basal dose of 60 kg P_2O_5 /ha through triple superphosphate, 40 kg K_2O /ha through muriate of potash, full dose of sulphur through gypsum and half dose of nitrogen through urea (as per treatment) were applied. Remaining N was

Table 1. Effect of nitrogen and sulphur levels on S content (%) in Indian mustard plant at different growth stages

Treatment	30 DAS		45 DAS		60 DAS		75 DAS		90 DAS	
	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90	1988-89	1989-90
<i>N (kg/ha)</i>										
0	0.223	0.214	0.239	0.246	0.210	0.210	0.178	0.205	0.161	0.185
30	0.264	0.267	0.263	0.269	0.221	0.229	0.184	0.231	0.171	0.209
60	0.273	0.287	0.284	0.285	0.329	0.269	0.212	0.251	0.184	0.226
90	0.280	0.294	0.286	0.307	0.246	0.283	0.239	0.264	0.207	0.230
CD (P = 0.05)	0.017	0.019	0.016	0.012	0.013	0.010	0.008	0.008	0.008	0.006
<i>S (kg/ha)</i>										
0	0.247	0.229	0.249	0.254	0.226	0.239	0.189	0.209	0.163	0.191
10	0.248	0.238	0.252	0.262	0.232	0.247	0.192	0.213	0.175	0.206
20	0.256	0.243	0.256	0.265	0.244	0.253	0.199	0.223	0.188	0.208
30	0.269	0.268	0.270	0.284	0.257	0.285	0.211	0.224	0.197	0.211
40	0.277	0.285	0.278	0.301	0.260	0.289	0.223	0.232	0.196	0.214
50	0.278	0.290	0.279	0.306	0.269	0.290	0.226	0.236	0.199	0.213
CD (P = 0.05)	0.020	0.023	0.018	0.015	0.016	0.012	0.011	0.010	0.010	0.007

DAS, Days after sowing

top-dressed 35 days after sowing just after the first irrigation. Two irrigations at 35 and 60 days after sowing were applied. Randomly selected plants from each net plot were uprooted, sun-dried, and oven-dried. Chemical analysis of plant and seed for N and S was done after proper drying and grinding. The S and N were determined by turbidimetric method (Chopra and Kanwar, 1976) and micro-Kjeldahl's procedure (Jackson, 1970) respectively. The percentage of oil was determined by solvent-extraction method in Soxhlets' apparatus with petroleum ether (BP 40–60°C) as solvent.

RESULTS AND DISCUSSION

Sulphur concentration

An increase in N up to 90 kg/ha increased the S concentration significantly in plant at

various growth stages, seed and stalk in both the years (Tables 1, 2). However, it was higher in seed than in stalk. Since both the nutrients are closely linked with protein metabolism and their relationship is synergistic (Aulakh and Pasricha, 1983).

An increase in sulphur level up to 30 kg/ha significantly increased the S content in plant at every crop-growth stage during both the years, and higher levels were at par (Table 1). The S content in plant was found to be increased with the advancement of plant growth up to 45 days after sowing, and thereafter declined gradually up to 90 days after sowing. Higher value of S at early stage could be due to greater root activity and less plant growth and also due to basal application of S, resulting in more soil S concentration and its availability which

Table 2. Concentration and uptake of sulphur by Indian mustard and residual balance in post-harvest soil as influenced by N and S levels

Treatment	S concentration (%) in				Total S uptake by crop (kg/ha)		Residual S* (kg/ha)	
	Seed		Stalk		A	B	A	B
	A	B	A	B				
<i>N (kg/ha)</i>								
0	0.448	0.439	0.140	0.163	2.09	2.73	11.43	14.34
30	0.467	0.468	0.169	0.174	3.83	4.30	13.79	20.31
60	0.493	0.498	0.184	0.189	6.10	6.37	14.83	22.48
90	0.516	0.518	0.196	0.202	7.80	7.87	14.98	23.38
CD (P = 0.05)	0.012	0.011	0.004	0.005	0.44	0.39	NS	NS
<i>S (kg/ha)</i>								
0	0.467	0.462	0.164	0.177	3.91	3.76	12.38	18.43
10	0.474	0.477	0.178	0.179	4.29	4.70	12.86	21.43
20	0.486	0.486	0.181	0.186	4.85	5.19	15.35	23.67
30	0.508	0.512	0.189	0.191	5.55	6.00	15.86	25.42
40	0.524	0.526	0.195	0.198	5.82	6.35	16.34	27.38
50	0.533	0.538	0.196	0.203	5.92	6.47	16.40	27.42
CD (P = 0.05)	0.015	0.013	0.005	0.006	0.540	0.48	NS	NS

A, 1988-89; B, 1989-90

*In post-harvest soil

Table 3. Effect on nitrogen and sulphur on seed yield, oil content and oil yield, N uptake and residual N balance in post-harvest soil under Indian mustard

Treatment	Seed yield (kg/ha)		Oil content (%)		Oil yield (kg/ha)		Total N uptake by crop (kg/ha)		Residual N* (kg/ha)	
	A	B	A	B	A	B	A	B	A	B
<i>N (kg/ha)</i>										
0	468	622	37.20	38.19	174	238	12.96	17.35	114.15	136.17
30	820	920	36.61	37.92	300	349	23.70	27.14	190.70	185.90
60	1,238	1,280	35.97	37.44	445	479	37.76	39.30	207.57	210.13
90	1,512	1,524	35.67	37.42	539	570	47.48	47.55	221.50	223.83
CD (P = 0.05)	143	46	0.31	0.20	27	35	5.72	10.58		
<i>S (kg/ha)</i>										
0	838	814	35.06	36.85	294	300	24.05	23.85	141.18	153.61
10	906	986	35.53	37.13	322	366	26.18	29.19	154.25	161.43
20	998	1,067	36.15	37.53	361	401	29.44	32.01	161.98	164.84
30	1,093	1,173	36.74	38.02	402	446	32.90	35.78	176.86	168.43
40	1,112	1,208	37.23	38.35	414	463	33.58	37.21	183.22	182.43
50	1,111	1,202	37.48	38.57	416	464	33.77	37.02	184.21	183.44
CD (P = 0.05)	172	56	0.38	0.24	34	42	7.02	12.95		

A, 1988-89; B, 1989-90

*Inn post-harvest soil

Table 4. Response function of nitrogen and sulphur fertilization to Indian mustard

Year	Response equation	R ²
<i>Nitrogen</i>		
1988–89	$Y = 4.47 + 0.1183 N$	0.943
1989–89	$Y = 6.266 + 0.1022 N$	0.931
Pooled	$Y = 5.52 + 0.1102 N$	0.939
<i>Sulphur</i>		
1988–89	$Y = 8.6124 + 0.0594 S$	0.952
1989–90	$Y = 8.8129 + 0.0775 S$	0.937
Pooled	$Y = 8.7156 + 0.0685 S$	0.946

Y, Expected grain yield; N, levels of nitrogen; S, levels of sulphur

increased the absorption by plant roots. The low absorption of S in the latter growth stage might be due to dilution effect (Aulakh *et al.*, 1977). Decrease in S content of the mature crop might be attributed to the translocation of the absorbed S to the growing parts, especially to seed (Tandon, 1990). Application of S up to 40 kg/ha increased the S content in seed and stalk during both the years. The N and S uptake by mustard crop increased significantly with 90 kg N and 30 kg S/ha during both the years, which may be due to the greater production of dry matter and seed yield with increasing N and S levels. Singh and Singh (1984) and Tandon (1990) also reported similar results.

For the residual balance of N and S in soil at post-harvest stage, the N status increased with an increase in levels of N, though it was not so much with the increasing S levels. Sulphur status was raised marginally with applied N and S.

Seed yield

The crop responded significantly for seed yield to application of N up to 90 kg/ha during both the years (Table 3). The yield increased due to 90 kg N/ha over no N was 223 and 145% during 1988–89 and 1989–90

respectively. The results confirm the findings of Singh and Singh (1984).

Application of S up to 30 kg/ha increased the seed yield significantly over the control during both the years. However, 30, 40 and 50 kg S/ha were at par. The increase in seed yield due to 30 kg S/ha over no S was 30.4 and 44.1% during 1988–89 and 1989–90 respectively. Such an increase in the seed yield might have resulted from the corresponding improvement of yield-attributing characters.

Oil content and oil yield

Nitrogen had an adverse effect on oil content of Indian mustard seed during both the years (Table 3). An increase in N from 0 to 90 kg/ha decreased the oil content by 1.53 and 0.77% during 1988–89 and 1989–90 respectively. At 90 kg N/ha it was 35.67 and 37.42%, whereas at no N the seed oil was higher, i.e. 37.20 and 38.19%, in first and second seasons respectively.

Application of S up to 40 kg/ha increased the oil content significantly in both the years, however, further increase in dose (50 kg S/ha) showed parity with the preceding level.

An appreciable improvement in oil yield

was noted due to supply of N up to 90 kg/ha and S up to 40 kg/ha during both the years. Increase in oil yield was mainly owing to increase in seed yield. The result confirms the finding of Tandon (1990).

The response of Indian mustard in terms of seed yield to nitrogen and sulphur was found to be linear (Table 4).

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