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Effect of nitrogen and sulphur on dry matter, grain yield and nitrogen content at different growth stages of mustard (*Brassica juncea*) under irrigated Vertisol

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ABSTRACT

A field experiment was conducted during the winter seasons of 1988–89 and 1989–90 at Powarkheda, to study the effect of nitrogen and sulphur on yield of mustard [*Brassica juncea* (L.) Czernj. & Cosson] under irrigated Vertisol. Nitrogen @ 90 kg/ha significantly increased the dry-matter production/plant, seed yield, nitrogent content in seed and plant of the mustard. Nitrogen had adverse effect on oil content of seed. Application of sulphur up to 30 kg/ha significantly increased the dry matter, seed yield, and N content in plant and seed, whereas S up to 40 kg/ha stimulated the oil content.

The productivity of mustard [*Brassica juncea* (L.) Czernj. & Cosson] can be increased by proper fertilizer management, bringing more area under irrigation and taking proper plant-protection measures. It is more responsive to fertilizers, especially nitrogen and sulphur (Antil *et al.*, 1986; Rathore and Manohar, 1990). The concentration of plant nutrients in a crop and the amount of nutrients in a crop and the amount of nutrients being removed by a particular crop from the soil may be helpful guide for formulation of a sound fertilizer-management programme (Tandon, 1989). However, little information is available on the effects of N and S on N concentration in mustard plants at different crop-growth stages, grain and stalk, the present investigation was undertaken under Tawa Command area in Central Narmada Valley.

MATERIALS AND METHODS

A field experiment was conducted during the winter (*rabi*) seasons of 1988–89 and 1989–90 at Powarkheda on clayey-loam soil. The soil contained 183.7 and 202.6 kg/ha available nitrogen, 13.6 and 13.4 kg/ha available P, 8.03 and 7.95 kg/ha available S and 301.4 and 333.8 kg/ha available K during 1988–89 and 1989–90 respectively. The treatments consisting of 4 N levels (0, 30, 60 and 90 kg/ha) and 6 S levels (0, 10, 20, 30, 40 and 50 kg/ha) were laid out in randomized block design with 3 replications. Mustard variety 'Varuna' was sown in rows 30 cm apart using 5 kg seed/ha on 28 October in 1988 and 3 November in 1989 and harvested 188 days after sowing. Basal application of 60 kg P_2O_5/ha through triple superphosphate, 40 kg K_2O/ha through muriate of potash, full dose of S (as per treatment) through gypsum and half dose of N (as per treatment) through urea were applied at the time of sowing. Remaining half dose of N through urea (as per treatment) was top-dressed at 35 days after

Table 1. Effect of nitrogen and sulphur levels on dry-matter production (g/plant) in mustard

Treatment	30 DAS		45 DAS		60 DAS		75 DAS		90 DAS		105 DAS		At harvest	
	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90	1988–89	1989–90	1988–89	1989 90
S (kg/ha)														
0	2.66	3.32	5.47	6.69	9.68	11.79	14.02	18.28	18.29	21.65	21.16	23.65	21.61	23.95
30	3.19	3.66	7.09	9.53	11.79	15.69	17.21	23.27	22.27	28.30	25.70	32.35	25.97	33.10
60	3.69	4.12	8.61	10.95	14.04	17.06	19.94	26.98	26.45	32.41	32.26	37.96	33.16	38.79
90	4.06	5.26	10.72	12.58	17.48	20.12	25.93	29.56	32.84	34.70	38.69	40.55	39.45	41.60
CD (P = 0.05)	0.21	0.19	0.38	0.36	0.37	0.59	0.94	0.74	1.42	0.87	1.53	0.88	1.26	1.25
S (kg/ha)														
0	3.15	3.72	6.68	8.46	11.23	14.31	16.79	21.66	21.64	25.11	24.64	28.41	24.94	28.56
10	3.22	3.91	7.38	9.18	12.13	16.38	18.44	23.15	23.27	28.98	26.72	32.88	27.02	32.92
20	3.33	4.05	7.77	9.46	12.99	16.51	19.86	24.18	24.96	30.31	28.86	34.66	29.31	35.26
30	3.46	4.17	7.91	10.06	13.73	17.11	20.28	25.59	26.08	31.96	30.28	36.76	30.88	37.06
40	3.59	4.35	8.15	10.04	15.00	17.54	22.00	26.25	28.80	32.69	32.23	37.79	32.55	38.59
50	3.64	4.35	8.25	10.42	14.66	17.47	22.07	26.02	27.62	32.02	31.82	37.67	32.42	38.82
CD (P = 0.05)	0.25	0.23	0.47	0.45	0.45	0.73	1.16	0.91	1.73	1.07	1.87	1.09	1.54	1.53

DAS, Days after sowing

Table 2. Effect of nitrogen and sulphur on seed yield, oil and N content in mustard seed and economics

Treatment	Seed yield (q/ha)		Oil content (%)		N content in seed (%)		N content in stalk (%)		Mean net profit (Rs/ha)	Mean net benefit : cost ratio
	A	B	A	B	A	B	A	B		
N (kg/ha)										
0	4.68	6.22	37.20	38.19	2.77	2.79	0.33	0.34	2,067	0.73
30	8.20	9.20	36.61	37.92	2.89	2.95	0.37	0.36	4,745	1.58
60	12.38	12.80	35.97	37.44	3.05	3.07	0.41	0.42	7,872	2.50
90	15.12	15.24	35.67	37.42	3.14	3.12	0.42	0.44	9,938	3.00
CD (P = 0.05)	1.43	0.46	0.31	0.20	0.04	0.023	0.002	0.011		
S (kg.ha)										
0	8.38	8.14	35.06	36.85	2.87	2.93	0.36	0.37	4,533	1.56
10	9.06	9.86	35.53	37.13	2.89	2.96	0.37	0.38	5,644	1.91
20	9.98	10.67	36.15	37.53	2.95	3.00	0.38	0.38	6,483	2.13
30	10.93	11.73	36.74	38.02	3.01	3.05	0.40	0.40	7,495	2.41
40	11.12	12.08	37.23	38.35	3.02	3.08	0.40	0.41	7,794	2.45
50	11.11	12.02	37.48	38.57	3.04	3.08	0.40	0.41	7,770	2.39
CD (P = 0.05)	1.72	0.56	0.38	0.24	0.05	0.03	0.29	0.014		

A, 1988–89; B, 1989–90

sowing just after first irrigation. Two irrigations were applied at 35 and 60 days after sowing in the crop during both the seasons. A standard sampling technique was adopted for recording the biomass observation. Plants were uprooted from each net plot and sun-dried. Thus, plant sample so obtained were placed for oven-drying at 75°–80°C for 48 hr and dry weight was taken. Chemical analysis of plant and seed for N was done after proper drying and grinding. The N was determined by modified Kjeldahl's method (Jackson, 1970). The percentage of oil was determined by solvent-extraction method in Soxhlet's apparatus with petrolium ether (BP 40–60°C) as solvent.

RESULTS AND DISCUSSION

Effect of N

Nitrogen significantly increased the dry-matter production, seed yield, N content in plant, seed and stalk and net profit. Increasing levels of N up to 90 kg/ha significantly increased the dry-matter production/plant (Table 1). This increase might be due to increased availability of N, causing accelerated photosynthetic rate and thus leading to more production of carbohydrates. This confirms the observations of Antil *et al.* (1986) and Singh and Saran (1987).

Seed yield significantly responded to application of N. The seed yield increased significantly with increasing levels of N up to 90 kg/ha. The increase in seed yield was 75.21, 164.53 and 223.08% owing to 30, 60 and 90 kg N/ha over no N (468 kg/ha) during 1988–89, and 47.91, 105.79 and 145.02% during 1989–90 with same N levels, as compared with the control (622 kg/ha). Saran and Giri (1990) also reported similar findings.

Nitrogen content significantly increased with the increase in N levels at all the crop-growth stages. The trend remained same in both the years (Table 3). N content was found to increase with the advancement of

Table 3. Interaction effect of N × S levels on mustard-seed yield

N (kg/ha)	S (kg/ha)						
	0	10	20	30	40	50	Mean
			1988–89				
0	3.83	4.44	4.66	5.16	5.00	4.97	4.08
30	6.67	7.30	7.96	9.08	9.02	9.15	8.20
60	10.87	11.60	12.01	13.02	13.74	13.63	12.38
90	12.16	13.43	15.27	16.44	16.72	16.69	15.12
CD (P = 0.05)				NS			
			1989–90				
0	4.49	5.93	6.10	6.70	7.19	6.89	6.22
30	7.63	8.74	8.96	9.79	9.97	10.13	9.20
60	11.01	11.15	12.24	13.89	14.20	14.30	12.80
90	12.21	13.62	15.36	16.54	16.96	16.76	15.24
CD (P = 0.05)				1.11			

Table 4. Effect of nitrogen and sulphur levels on nitrogen content (%) in 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
N (kg/ha)										
0	1.53	1.64	1.60	1.65	1.35	1.28	1.17	1.20	1.09	1.18
30	1.72	1.78	1.76	1.76	1.41	1.52	1.23	1.35	1.14	1.25
60	1.85	1.89	1.90	1.90	1.52	1.80	1.41	1.48	1.26	1.37
90	1.89	2.01	1.92	2.02	1.64	1.96	1.50	1.53	1.38	1.46
CD (P = 0.05)	0.058	0.065	0.050	0.060	0.043	0.053	0.042	0.044	0.026	0.035
S (kg/ha)										
0	1.62	1.68	1.63	1.69	1.53	1.59	1.25	1.30	1.08	1.19
10	1.65	1.71	1.68	1.72	1.57	1.63	1.28	1.36	1.16	1.22
20	1.73	1.72	1.72	1.73	1.63	1.72	1.32	1.38	1.22	1.34
30	1.75	1.80	1.77	1.83	1.69	1.76	1.36	1.42	1.30	1.36
40	1.81	1.83	1.83	1.84	1.72	1.83	1.39	1.44	1.32	1.39
50	1.82	1.86	1.83	1.87	1.75	1.83	1.40	1.43	1.33	1.39
CD (P = 0.05)	0.071	0.080	0.060	0.074	0.053	0.065	0.05	0.055	0.03	0.043

plant growth up to 45 days after sowing but as the crop age advanced, a decrease in its content was noticied. The interaction were not found to be significant.

Nitrogen contents in seed and stalk were also increased significantly with N up to 90 kg/ha (Table 2). The probable reason was that the N absorbed by plants was translocated from source to sink, i.e. from vegetative parts to the seed. The results are in confirmity with the findings of Tandon (1989).

Nitrogen had adverse effect on oil content. It was obvious from data presented data in Table 2 that as the level of N increased from 0 to 90 kg/ha, the oil content was reduced 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.

Effect of sulphur

Sulphur application enhanced markedly the dry matter, seed yield and N content in plant and seed, oil content and net profit. Application of S up to 30 kg/ha significantly the increased dry matter. The increase in dry matter might be attributed to better nutritional environment for plant growth. Singh and Saran (1987) also reported similar results.

An increase in level of S up to 30 kg/ha incresed the seed yield significantly over the control. 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 (Table 2). Singh and Saran (1987) also reported similar results.

Interaction effect of N × S was significant during 1989–90 only. At lower levels of N, the mustard responded to S significantly up to 10 kg/ha. However, with increased supply of N (60–90 kg N/ha), the S need of the crop was significantly raised to 30 kg S/ha. However, irrespective doses of S, mustard crop responded to up to 90 kg/ha (Table 3).

Application of S up to 30 kg/ha stimulated the N content in mustard plant at every crop-growth stage. Irrespective of S levels, the response of N content in plant was increased up to 45 days after sowing and then declined up to 90 days after sowing (Table 4). Nitrogen contents in grain and stalk were also increased significantly with S up to 30 kg/ha. Higher levels of S (30, 40 and 50 kg/ha) were at par (Table 2).

Increasing levels of S up to 40 kg/ha increased the oil content significantly. At this S level, the oil content was 37.43 and 38.35% in first and second seasons respectively. However, further increase in dose of S, i.e. 50 kg/ha, was at par with 40 kg S/ha (Table 2). The interaction effect was not found to be significant. Sawarkar *et al.* (1987) made similar observation with sulphur.

Pooled results showed that maximum net return was obtained from 90 kg N/ha (Table 2). The net return per rupee invested on cultivation of mustard was maximum (3.00) with 90 kg N/ha and minimum (0.73) at no N. Similarly, sulphur @ 40 kg/ha gave maximum net profit with a net benefit: cost ratio of 2.45, as extra gain being Rs 3,261/ha over no S level.

It was concluded that 90 kg N and 30 kg S/ha would be the optimum doses for realizing the best growth of plant, seed yield, oil and nitrogen contents of mustard crop under irrigated conditions of deep Vertisol in Tawa Command Area of Central Narmada Valley.

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