

## Nitrogen, sulphur and calcium relationship in sustainable production of Indian Mustard (*Brassica juncea*) on denuded land

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Received: 6 June 1998

### ABSTRACT

A relationship of nitrogen, sulphur and calcium for sustainable production of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson] on denuded sandy-loam soils was investigated, during winter seasons of 1993–94 and 1994–95. 'Varuna' Indian mustard was tested under 5 levels of nitrogen (0, 40, 80, 120 and 160 kg/ha) and 3 levels of sulphur + calcium ( $S_0 + Ca_0$ ,  $S_{25} + Ca_{50}$  and  $S_{50} + Ca_{100}$  kg/ha). Use of nitrogen in nutrients denuded soils established a strong relationship for grain production of Indian mustard. Branches, pods, pod weight, seeds weight/plant and 1,000-grain weight increased significantly with each successive increase in the level of N from 0 to 160 kg and S from 0 to 50 + Ca from 0 to 100 kg/ha. The increase in the yield after 120 kg N/ha was significant by a margin of 3.79 q/ha or 13.07% with higher dose of 160 kg N/ha. The use of 50 kg S + 100 kg Ca/ha also increased grain yield by a margin of 1.99 q/ha or 8.35 % and 3.33 q/ha or 14.75% over 25 kg S + 50 kg Ca/ha and the control respectively. The significant maximum yield by 34.87 q/ha was reaped with the use of 160 kg N + 50 kg S + 100 kg Ca/ha.

**Key words :** Indian mustard, N, S, Ca, Sustainable yield

In Indian mustard the major cause of low grain and oil yield is the imperfect integration of essential plant nutrients. There are complementary and supplementary relationship among the nitrogen, phosphorus, sulphur and calcium. The sulphur helps in chlorophyll formation with nitrogen. Similarly, calcium improves intake of N by correcting soil pH. The use of S and Ca increases the root development with phosphorus (Yawalker *et al.*, 1972). With a view

to establish strong relationship between the N, S and Ca, the present experiment was planned and conducted under situation-base study.

### MATERIALS AND METHODS

The field experiment was laid out during the winter (*rabi*) season of 1993–94 and 1994–95 at Regional Research Station, Mainpuri, Uttar Pradesh. The soil was sandy loam, having pH 8.5 due to calcium

**Table 1.** Growth and yield attributes of 'Varuna' Indian mustard as influenced by different levels of N, S and Ca

Treatment	Branches/plant			Pods/plant			Pods weight/plant (g)		
	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average
<i>N (kg/ha)</i>									
0	51.25	50.36	50.80	456.44	451.44	453.94	40.55	39.96	40.25
40	55.33	54.40	54.86	534.96	532.40	533.68	50.77	49.99	50.38
80	58.10	57.07	57.58	592.58	587.40	589.99	52.62	51.85	52.23
120	63.64	62.10	62.87	633.10	627.40	630.25	60.55	59.77	60.16
160	73.14	72.07	72.60	710.73	701.07	705.90	75.18	74.55	74.86
CD (P = 0.05)	0.49	0.66		4.48	4.57		0.40	0.57	
<i>S + Ca (kg/ha)</i>									
S <sub>0</sub> +Ca <sub>0</sub>	58.61	57.55	58.08	554.08	549.39	551.73	42.41	41.75	42.08
S <sub>25</sub> +Ca <sub>50</sub>	60.24	59.26	59.75	590.08	582.55	586.31	58.21	57.46	57.83
S <sub>50</sub> +Ca <sub>100</sub>	61.73	60.79	61.26	612.53	607.88	610.20	67.17	66.46	66.81
CD (P = 0.05)	0.37	0.52		3.47	3.53		0.31	0.43	

Y<sub>1</sub>, 1993-94; Y<sub>2</sub>, 1994-95**Table 2.** Yield attributes and seed yield of 'Varuna' Indian mustard under different levels of nitrogen, sulphur and calcium

Treatment	Seed weight/plant (g)			1,000-seed weight (g)			Seed yield (q/ha)		
	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average
<i>N (kg/ha)</i>									
0	17.95	17.29	17.62	4.51	4.42	4.46	14.27	14.13	14.20
40	20.58	19.96	20.27	4.52	4.48	4.50	21.49	19.75	20.62
80	25.32	24.92	25.12	4.66	4.63	4.64	24.87	23.18	24.02
120	28.92	28.55	28.73	4.90	4.86	4.88	30.11	27.85	28.98
160	35.10	34.66	34.88	5.01	4.97	4.99	33.31	32.24	32.77
CD (P = 0.05)	0.43	0.43		0.05	0.05		1.62	2.37	
<i>S + Ca (kg/ha)</i>									
S <sub>0</sub> +Ca <sub>0</sub>	18.10	17.70	17.90	4.46	4.59	4.61	23.32	21.81	22.56
S <sub>25</sub> +Ca <sub>50</sub>	25.90	25.39	25.64	4.72	4.68	4.70	24.68	23.13	23.90
S <sub>50</sub> +Ca <sub>100</sub>	32.72	32.13	32.42	4.80	4.76	4.78	26.43	25.35	25.89
CD (P = 0.05)	0.31	0.34		0.05	0.05		1.24	1.82	

Y<sub>1</sub>, 1993-94; Y<sub>2</sub>, 1994-95

nodulation, organic C 0.45%, total N 0.04%, available P 10 kg/ha and available K 278 kg/ha, indicating low-fertility status of the soil. The treatments consisted of 5 doses of N (0, 40, 80, 120 and 160 kg/ha) and 3 doses of S and Ca ( $S_0 + Ca_0$ ,  $S_{25} + Ca_{50}$  and  $S_{50} + Ca_{100}$  kg/ha). The common doses of P and K were applied @ 40 kg  $P_2O_5$  and  $K_2O$ . The S and Ca were supplied through gypsum @ 165 kg and 350 kg/ha to fulfil the doses of  $S_{25} + Ca_{50}$  and  $S_{50} + Ca_{100}$  kg/ha respectively. The half dose of N and full doses of  $P_2O_5$ ,  $K_2O$ , S and Ca were given at planting. The remaining N was top-dressed after final thinning and first irrigation at day 35 of sowing. The trial was

laid out in 3- replicated randomized block design. The crop was planted in rows 45 cm apart using 5 kg seed/ha. Three irrigations were given to crop 30, 60 and 90 days after sowing. 'Varuna' was sown in last week of October and harvested 130 days after sowing in the second week of March, during both experimental years. Well-sundried crop was threshed, winnowed and weighed 15 days after harvesting.

## RESULTS AND DISCUSSION

### Nitrogen

Nitrogen @ 160 kg/ha resulted in significantly more seed yield than the lower doses. It brought about an all-round signifi-

**Table 3.** Seed yield of Indian mustard under combined effect of nitrogen, sulphur and calcium (q/ha)

S + Ca (kg/ha)	N (kg/ha)					Average
	0	40	80	120	160	
<i>1993-94</i>						
Control	12.51	20.15	23.15	28.49	32.10	23.32
$S_{25} + Ca_{50}$	14.60	21.26	24.60	29.88	33.08	24.68
$S_{50} + Ca_{100}$	15.70	23.07	26.68	31.97	34.75	26.43
Average	14.27	21.49	24.87	30.11	33.31	24.81
<i>CD (P = 0.05)</i>						
N	1.62					
S + Ca	1.24					
N × S + Ca	NS					
<i>1994-95</i>						
Control	12.35	18.52	21.81	25.93	30.46	21.81
$S_{25} + Ca_{50}$	14.40	19.34	23.05	27.58	31.28	23.13
$S_{50} + Ca_{100}$	15.64	21.40	24.70	30.05	34.99	25.35
Average	14.13	19.15	23.18	27.85	32.24	23.43
<i>CD (P = 0.05)</i>						
N	2.37					
S + Ca	1.82					
N × S + Ca	NS					

cant improvement in all growth and yield attributes, which resulted in significantly higher seed yield (Tables 1, 2).

The use of nitrogen in nutrients denuded soils indicated a strong linear relationship of grain yield of mustard with nitrogen dose, during both the years, and even the increase in the yield after 120 kg N/ha was significant being 13.07 % with the higher dose of 160 kg N/ha.

The increase in the N level in nutrients denuded soils was responsible for all-round development of growth of Indian mustard, causing higher photosynthesis and assimilation rate and metabolic activity and cell-division. And these were found responsible for the significant increase in values of growth characters, yield attributes and ultimately the seed yield. The results confirm the findings of Rathi and Singh (1983) Singh and Rathi (1984) and Singh

and Rathi (1985).

### **Sulphur and calcium**

Branches/plant, pods/plant, pods weight/plant, seed weight/plant, 1,000-grain weight and seed yield/ha increased significantly with each successive increase in the level of S from 0 to 50 kg/ha + calcium from 0 to 100 kg/ha in the form of gypsum. The use of 50 kg S + 100 kg Ca/ha in the form of gypsum increased the seed yield by a margin of 3.33 q/ha or 14.75 % and 1.99 q/ha or 8.35% over the control and 25 kg S + 50 kg Ca/ha respectively (Tables 1, 2). Chauhan *et al.* (1995) also reported the beneficial effect of gypsum on seed yield of Indian mustard.

The increasing levels of S might increased growth, which resulted in increased photosynthesis and assimilation

**Table 4.** Nitrogen, sulphur and calcium uptake (kg/ha) by 'Varuna' Indian mustard as affected by applied nutrients

Treatment	Nitrogen			Sulphur			Calcium		
	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average	Y <sub>1</sub>	Y <sub>2</sub>	Average
<i>N (kg/ha)</i>									
0	46.41	46.25	46.33	27.24	26.90	27.07	40.86	40.35	40.60
40	94.27	88.90	91.58	41.10	37.62	39.36	61.65	56.43	59.04
80	118.17	111.19	114.68	47.46	44.64	46.05	71.20	66.96	69.08
120	150.57	138.38	144.47	57.44	52.91	55.17	86.15	79.70	82.92
160	166.79	161.22	164.00	63.81	61.49	62.65	95.73	92.24	93.98
CD (P = 0.05)	9.32	11.38		3.07	4.83		4.60	7.90	
<i>S + Ca (kg/ha)</i>									
S <sub>0</sub> + Ca <sub>0</sub>	107.62	102.02	104.82	44.65	41.57	43.11	66.98	62.35	64.66
S <sub>25</sub> + Ca <sub>50</sub>	114.99	107.52	111.25	47.08	43.97	45.52	70.62	65.95	68.28
S <sub>50</sub> + Ca <sub>100</sub>	123.15	118.02	120.58	50.50	48.61	49.55	75.75	73.11	74.43
CD (P = 0.05)	7.21	8.80		2.37	3.73		3.56	6.14	

Y<sub>1</sub>, 1993-94; Y<sub>2</sub>, 1994-95

**Table 5.** Cost of cultivation, gross return, net profit and benefit : cost under different doses of nitrogen and sulphur + calcium

Treatment	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net profit (Rs/ha)	Benefit : cost (Rs)
<i>N (kg/ha)</i>				
0	9,952	15,620	5,668	1.57
40	10,308	22,682	12,374	2.20
80	10,664	26,422	15,758	2.47
120	11,020	31,878	20,858	2.89
160	11,376	36,047	24,671	3.16
<i>S + Ca (kg/ha)</i>				
S <sub>0</sub> + Ca <sub>0</sub>	10,447	24,816	14,369	2.37
S <sub>25</sub> + Ca <sub>50</sub>	10,628	26,290	15,662	2.47
S <sub>50</sub> + Ca <sub>100</sub>	10,918	28,479	17,561	2.60

rates, cell-division and cell elongation or expansion. These in turn increased the seed yield. Mohan and Sharma (1992) also reported the significant increase in the seed yield owing to S application up to 50 kg S/ha.

Similarly, increasing levels of calcium also promoted growth and early root development of Indian mustard and improved the intake of other trace elements by correcting soil pH and resulted in encouraged seed production.

#### **Combined effect of nitrogen, sulphur and calcium**

The interaction effect of N and S + Ca on growth and yield attributes was found significant, resulting in increased seed yield significantly up to the higher doses of N and S + Ca (Table 3).

#### **Nitrogen, sulphur and calcium uptake**

The total uptake of N, S and Ca

consistently increased with each additional of N up to 160 also kg/ha. Similarly, each increment of S + Ca dose also resulted in a significant increase in N, S and Ca uptake. The significantly higher total uptake of N, S and Ca were found at S<sub>50</sub> + Ca<sub>100</sub> kg/ha and lowest in the control (Table 4). The higher uptake of N, S and Ca are closely correlated with their increased availability in soil by fertilization due to increased yields.

Since the soil under investigation is deficient in available N, S and Ca, their uptake in synergistic nature is quite possible even at their higher application rates.

#### **Economics**

The cost of cultivation varied according to the different doses of N and S + Ca. The maximum net return and benefit : cost ratio were obtained with 160 kg N/ha. Similarly, the highest net return and benefit : cost ratio

were calculated at maximum dose of  $S_{50} + Ca_{100}$  (Table 5).

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