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Effect of Sulfur Levels and Mustard Varieties on Growth, Yield and Oil Content in Sandy Loam Soils of Jharkhand

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Abstract

The experiment was conducted in medium land condition with deep soil depth during *rabi* season of 1997-98. The soil was sandy loam and acidic in nature. It had high permeability and low water holding capacity. The soil was well aggregated due to presence of hydrates oxides of iron and aluminum. The high rainfall (2,065 mm during 1997), 80-90% of annual precipitation during June to September in this region favors high rate of leaching of plant nutrients from such soil and is often caused nutrient deficiency which needs to be corrected to maintain high level of crop production. Crop like rapesced and mustard require large amount of sulfur for synthesis of sulfur containing amino-acid, protein and oil and its adequate supply increase the crop yield. The effect of different levels of sulfur in boosting the mustard growth, oil content and yield in Chotanagpur region was also studied. The sulfur in addition to other nutrients increased the productivity and quality of mustard.

Key words : Sulfur levels, Mustard varieties, Growth, Yield, Oil content.

Mustard *Brassica compestris* Linn. is one of the most important oilseed crop and belongs to the family *Cruciferae.* Over 90% of the entire production of mustard is consumed in the country in different forms.The tender mustard leaves and shoots are used as vegetables. The seed contains 27—50% of fatty oil and about 20% protein matter. The growing area of rapeseed and mustard is 6.47 million ha with annual production 6.72 million tonnes in India, and productivity of about 10.3 q/ha (1). The area under rapeseed and mustard in plateau region of Chotanagpur is about 16,412 ha with an annual production of 5,769 tonnes with productivity of 3.51 q/ha. The productivity of rapeseed and mustard in plateau region of Chotanagpur is very low in comparison to India and Bihar. Crop requires a good amount of sulfur as they require phosphorus. The total sulfur requirement of a crop depends on the type of crop, varieties, yield levels and the amount of sulfur availability to it. To produce higher yields year after year, it is necessary that the sulfur requirement of crop is adequately met. Sulfur is now recognized as the major nutrients for yield production and better quality of the crop.

Methods

Field experiment was conducted in medium land, acidic sandy loam soil at Birsa Agricultural University, Kanke, Ranchi with deep soil depth in lake south section (Plot No.49) during the *rabi* season of 1997-98 to study the response of levels of sulfur on mustard varieties *(Brassica Juncea).* The locality annual rainfall was 1,480 mm. The mean maximum temperature was 23.17 C, 21.78 C at vegetative, reproductive and maturity growth stages. At the time of sowing average weekly maximum temperature was 27.70 C and minimum temperature was 16.5 C.

The field experiment were laid out in randomized block design and replicated thrice. Each replication had twelve treatments having three mustard varieties (Pusa bold, BR-40 and Varuna) and four levels of sulfur (0, 15, 30, 45 kg/ha). The experiment comparising 12 treatments combination i.e. T_1—V_1S_0 (Pusa bold and 0 kg S/ha), T_2—V_1S_{15} (Pusa bold and 15 kg S/ha), T_3—V_1S_{30} (Pusa bold and 30 kg S/ha), T_4—V_1S_{45} (Pusa bold and 45 kg S/ha), T_5—V_2S_0 (BR—40 and O kg S/ha), T_6 —V_2S_{15} (BR—40 and 15 kg S/ha), T_7—V_2S_{30} (BR— 40 and 30 kg S/ha), T_8—V_2S_{45} (BR—40 and 45 kg S/ha), T_9—V_3S_0 (Varuna and 0 kg S/ha), T_{10}—V_3S_{15} (Varuna and 15 kg S/ha), T_{11}—V_3S_{30} (Varuna and 30 kg S/ha), T_{12}—V_3S_{45} (Varuna and 45 kg S/ha).

The source of sulfur used in this investigation

Table 1. Effect of sulfur levels and mustard varieties on plant height (cm) at different growth stages.

Level of S kg/ha	Varieties			
	Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean
At 30 Days after Sowing				
S_0	9.79	8.33	7.84	8.82
S_{15}	11.11	10.08	8.62	9.94
S_{30}	13.19	10.54	9.41	11.05
S_{45}	15.35	11.70	10.70	12.59
Mean	12.36	10.28	9.14	-
At 45 Days after Sowing				
S_0	60.00	56.20	45.70	53.96
S_{15}	67.00	60.00	53.70	60.23
S_{30}	71.00	62.00	60.00	64.40
S_{45}	78.00	65.00	72.50	71.80
Mean	69.05	60.80	57.97	-
At 60 Days after Sowing				
S_0	92.00	83.70	87.20	87.63
S_{15}	97.50	94.70	93.20	95.23
S_{30}	101.79	108.00	98.20	102.63
S_{45}	116.00	112.70	108.20	112.30
Mean	101.80	99.77	96.77	-
At 75 Days after Sowing				
S_0	107.70	106.20	99.00	104.30
S_{15}	112.50	111.00	105.50	109.60
S_{30}	119.20	114.00	106.20	113.10
S_{45}	127.20	122.20	109.50	119.63
Mean	116.65	113.35	105.05	-
At on Harvest				
S_0	114.70	113.50	109.50	112.56
S_{15}	122.50	117.20	105.00	114.90
S_{30}	131.70	119.70	110.00	120.90
S_{45}	139.70	130.70	114.70	128.36
Mean	127.15	120.27	110.05	-

Table 1. Continued.

Level of S kg/ha			
At 30 Days after Sowing			
		SE (±)	CD at 5%
S_0	Levels (L)	0.61	1.76
S_{15}	Varieties (V)	0.53	1.52
S_{30}	Interaction (L × V)	1.06	NS
S_{45}	CV %	20.0	
Mean			
At 45 Days after Sowing		SE (±)	CD at 5%
S_0	Levels (L)	3.019	8.68
S_{15}	Varieties (V)	2.614	7.52
S_{30}	Interaction (L × V)	5.228	NS
S_{45}	CV %	16.70	
Mean			
At 60 Days after Sowing		SE (±)	CD at 5%
S_0	Levels (L)	3.10	8.89
S_{15}	Varieties (V)	2.67	NS
S_{30}	Interaction (L × V)	5.35	NS
S_{45}	CV %	10.8	
At 75 Days after Sowing		SE (±)	CD at 5%
S_0	Levels (L)	3.54	10.17
S_{15}	Varieties (V)	3.07	8.8
S_{30}	Interaction (L ×V)	6.14	NS

Table 1. Continued.

Level of S kg/ha			
S_{45}	CV %	11.0	
Mean			
At on Harvest		SE (±)	CD at 5%
S_0	Levels (L)	3.78	10.86
S_{15}	Varieties (V)	3.27	9.40
S_{30}	Interaction (L × V)	6.55	NS
S_{45}	CV %	10.9	
Mean			

was single super phosphate supplemented by gypsum. The crop was seeded on 14 November 1997. An uniform dose of 50 kg N, 50 kg P_2O_5 and 20 kg K_2O/ha was given to the crop. The experimental soil was sandy loam having sand, silt and clay percentage (68.40, 16.40 and 15.20%, respectively). Soil pH was 6.0, organic carbon 5.6%, available N 213.25, P_2O_5 36.4, K_2O 186.0 and S 18.23 kg/ha. The soil was analyzed for sand, silt and clay by international pipettee method given by Piper (2), soil pH by glass electrode pH meter given by Jackson (3), organic carbon by Walkley and Black method (4) and sulfur by colori-

Table 2. Effect of sulfur levels and mustard varieties on number of branch per plant at different growth stages.

Lavel of S kg/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Veruna (V_3)	Mean			
At 45 Days after Sowing							
						SE (±)	CD at 5%
S_0	0.7	2.1	1.5	1.43	Levels (L)	0.22	0.642
S_{15}	1.2	3.3	2.1	2.20	Varieties (V)	0.20	0.560
S_{30}	2.1	4.6	3.1	3.26	Interaction (L × V)	0.38	NS
S_{45}	2.6	5.1	3.9	3.86	CV %	16.80	
Mean	1.65	3.77	2.65	-			
At 60 Days after Sowing							
						SE (±)	CD at 5%
S_0	3.7	4.0	3.9	3.87	Levels (L)	0.16	0.46
S_{15}	4.4	4.8	4.4	4.53	Varieties (V)	0.14	0.39
S_{30}	4.8	5.4	4.9	5.03	Interaction (L × V)	0.28	NS
S_{45}	5.1	6.2	5.0	5.43	CV %	11.58	
Mean	4.5	5.1	4.5	-			
At 75 Days after Sowing							
						SE (±)	CD at 5%
S_0	4.4	4.4	4.4	4.40	Levels (L)	0.20	0.58
S_{15}	4.9	4.9	4.8	4.86	Varieties (V)	0.17	NS
S_{30}	4.9	5.4	4.9	5.06	Interaction (L × V)	0.35	NS
S_{45}	5.0	6.2	5.2	5.46	CV %	14.07	
Mean	4.8	5.22	4.82	-			
At on Harvest							
						SE (±)	CD at 5%
S_0	4.4	4.6	4.6	4.53	Levels (L)	0.17	0.50
S_{15}	4.9	5.2	5.1	5.06	Varieties (V)	0.15	NS
S_{30}	5.1	5.5	5.5	5.37	Interaction (L × V)	0.30	NS
S_{45}	5.7	6.2	6.2	6.03	CV %	11.45	
Mean	5.02	5.37	5.35	-			

Table 3. Effect of sulfur levels and mustard varieties on dry matter per plant (g).

Level of S kg/ha	Varieties Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean			
At 30 Days after Sowing							
						SE (±)	CD at 5%
S_0	0.52	0.75	0.30	0.52	Levels (L)	0.051	0.15
S_{15}	0.62	0.80	0.70	0.71	Varieties (V)	0.450	0.13
S_{30}	0.72	1.10	0.80	0.88	Interaction (L × V)	0.088	NS
S_{45}	0.72	1.20	0.95	0.95	CV %	23.12	
Mean	0.64	0.96	0.69	-			
At 45 Days after Sowing							
						SE (±)	CD at 5%
S_0	3.20	4.30	4.1	3.87	Levels (L)	0.13	0.39
S_{15}	3.90	4.60	4.5	4.33	Varieties (V)	0.11	0.34
S_{30}	4.90	5.70	4.7	5.10	Interaction (L × V)	0.23	0.65
S_{45}	5.40	6.30	5.2	5.63	CV %	10.0	
Mean	4.35	5.22	4.62	-			
At 60 Days after Sowing							
						SE (±)	CD at 5%
S_0	6.0	7.2	5.60	6.27	Levels (L)	0.39	1.12
S_{15}	6.0	9.2	6.60	7.27	Varieties (V)	0.32	0.91
S_{30}	7.2	10.0	7.60	8.27	Interaction (L × V)	0.64	NS
S_{45}	7.2	10.4	8.00	8.53	CV %	17.76	
Mean	6.6	9.2	6.95	-			
At 75 Days after Sowing							
						SE (±)	CD at 5%
S_0	6.1	9.3	6.6	7.33	Levels (L)	0.52	1.51
S_{15}	6.7	9.6	7.3	7.86	Varieties (V)	0.45	1.31
S_{30}	8.0	12.2	8.4	9.53	Interaction (I × V)	0.91	NS
S_{45}	9.1	12.5	8.9	10.16	CV%	20.88	
Mean	7.22	10.92	7.82	-			
At on Harvest							
						SE (±)	CD at 5%
S_0	6.7	17.0	12.7	12.13	Levels (L)	0.69	1.98
S_{15}	11.1	21.3	16.2	16.20	Varieties (V)	0.60	1.72
S_{30}	12.7	23.3	22.3	19.43	Interaction (L×V)	1.20	NS
S_{45}	12.9	26.6	23.2	20.90	CV%	13.91	
Mean	10.85	22.05	18.6	-			

metric method (4).

Results and Discussion

Plant Height

Plant height of mustard crop was recorded at 30, 45, 60, 75 days after sowing and at harvest stage (Table 1). Increasing levels of sulfur significantly increased the plant height up to 45 kg/ha. The progressive increase in plant height at harvest was 2.07, 7.32 and 14.03% at 15, 30 and 45 kg/ha S levels respectively as compared to control. Pusa bold plant attained the maximum height at all the stages of observation and Varuna recorded the lowest height. At harvest stage, Pusa bold (V_1) and BR-40 (V_2) recorded 15.53 and 9.28% more plant height respectively as compared to variety Veruna (V_3). The effect of interaction between sulfur level level and mustard varieties on plant heigh was not found to be significant.

Number of Branches per Plant

The number of branch per plant increased significantly at all growth stages with successive increase

Table 4. Effect of sulfur levels and mustard varieties on number of siliqua per plant.

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE (±)	CD at 5%
S_0	81.75	118.00	81.5	93.73	Levels (L)	6.13	17.65
S_{15}	113.75	130.00	117.25	120.33	Varieties (V)	5.31	15.28
S_{30}	132.75	142.75	147.00	140.83	Interaction (L × V)	10.26	NS
S_{45}	164.25	169.25	165.25	166.25	CV %	16.31	
Mean	123.125	140.00	127.75				

Table 5. Effect of sulfur levels and mustard varieties on number of seed per siliqua at harvest.

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE (±)	CD at 5%
S_0	10.0	15.2	10.3	11.83	Levels (L)	0.29	0.82
S_{15}	11.6	15.3	10.6	12.50	Varieties (V)	0.25	0.72
S_{30}	11.6	16.0	13.2	13.60	Interaction (L × V)	0.49	1.40
S_{45}	13.2	16.2	13.8	14.40	CV %	7.6	
Mean	11.6	15.67	11.97				

in sulphur upto 45 kg S/ha. Number of branches per plant were maximum under 45 kg/ha S levels which was significantly higher than control and 15 kg S/ha but at par with 30 kg S/ha at 60, 75 days harvest stages. At harvest stage the application of 45 kg/ha sulfur recorded the maximum (6.03) and minimum (4.53) number of branches per plant in control respectively. Mustard variety BR-40 had significantly more number of branches per plant at 45 (3.77) and 60 (5.10) days of crop growth stages than Pusa bold (V_1) and Varuna (V_3). At 75 days at harvest stage varietal difference in respect to number of branches per plant was not statistically significant. However, BR-40 recorded the highest number of branches per plant 5.22 and 5.37 and at 75 days at harvest stage respectively. Interaction between sulfur levels (S) and varieties (V) was found to be non-significant. (Table 2).

Dry Matter per Plant

Crop with increasing levels of sulfur upto 45 kg/ha accumulated maximumn dry matter throughout crop growing period. This sulfur helps in increasing the photosynthetic activity of plant. Application of 45 kg S/ha recorded the maximum dry matter (0.95, 5.63, 8.53, 10.16 and 20.90 g/plant) at 30, 45, 60, 75 days of sowing and at harvest stage respectively. BR-40 (V_2) plants had significantly more dry weight per plant than Pusa bold (V_1) and Varuna (V_3) at all the stages of crop growth. Pusa bold gave the lowest dry weight per plant at all stages of crop growth. At harvest BR-40, Varuna and Pusa bold recorded 22.05, 18.60 and 10.85 g of dry matter per plant respectively. Interaction between sulfur level (S) and variety (V) was found non-significant at all growth stages of crop except at

Table 6. Effect of sulfur levels and mustard varieties on seed yield (kg/ha).

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE (±)	CD at 5%
S_0	612	725	678	672	Levels (L)	26.8	76.9
S_{15}	672	745	732	716	Varieties (V)	23.2	66.6
S_{30}	768	879	770	805	Interaction (L × V)	46.4	NS
S_{45}	862	952	871	895	CV %	12.02	
Mean	729	825	763				

Table 7. Effect of sulfur levels and mustard varieties on straw yield (kg/ha).

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE (±)	CD at 5%
S_0	1957	2026	2006	1996	Levels (L)	81.2	233.2
S_{15}	1987	2142	2082	2070	Varieties (V)	70.3	NS
S_{30}	2248	2443	2272	2321	Interaction (L × V)	140.7	NS
S_{45}	2323	2696	2559	2560	CV %	12.65	
Mean	2129	2326	2230				

Table 8. Effect of sulfur levels and mustard varieties on biological yield (kg/ha).

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Veruna (V_3)	Mean		SE (±)	CD at 5%
S_0	2569	2751	2684	2668	Levels (L)	94	272
S_{15}	2659	2887	2814	2786	Varieties (V)	82	236
S_{30}	3016	3222	3042	3093	Interaction (L × V)	1646	471.9
S_{45}	3185	3648	3420	3418	CV %	11.0	
Mean	2857	3127	2992				

45 days of crop growth (Table 3). Favorable influence of sulphur in crop growth of mustard has also been reported by Chatterjee et al. (5), Chaudhary and Sharma (6), Mahato (7) and Aulakh et al. (8).

Number of Siliqua per Plant and Number of Seed per Siliqua

Sulfur levels significantly affect the number of siliqua per plant and number of seed per siliqua. Sulfur levels at 45 kg/ha recorded the maximum number of siliqua per plant (166.25) and number of seed per siliqua (14.40) while control plot (0 kg S/ha) recorded the minimum no. of siliqua per plant (93.73 and number of seed per siliqua 11.83). Variety BR-40 (V_2) recorded the maximum number of siliqua per plant (140) and number of seed per siliqua (15.67) and variety Pusa bold (V_1) recorded minimum number of siliqua per plant (123.12) and no. of seed per siliqua (11.6). (Tables 4, 5).

Yield

Seed, straw and biological yield were influenced by sulfur nutrition. Application of 45 kg S/ha recorded the maximum seed (895 kg/ha), straw (2560 kg/ha) and biological yield (3418 kg/ha) and control plot gave the minimum seed (672 kg/ha), straw (1996 kg/ha) and biological yield (2668 kg/ha). Different mustard variety BR-40 recorded 13.17, 9.25 and 9.45% more seed, straw and biological yield than Pusa Bold (V_2) as indicated in Tables 6—8.

Oil quality

The maxmum oil (399.88 kg/ha) was recorded when 45 kg S/ha was applied which was significantly

Table 9. Effect of sulfur levels and mustard varieties on oil yield (kg/ha).

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE (±)	CD at 5%
S_0	271.05	311.24	300.08	294.12	Levels (L)	6.91	19.83
S_{15}	300.52	322.58	325.15	316.08	Varieties (V)	5.98	17.17
S_{30}	347.52	382.89	343.57	357.99	Interaction (L × V)	11.97	34.44
S_{45}	391.26	418.02	390.38	399.88	CV %	7.0	
Mean	327.59	358.68	339.79				

Table 10. Effect of sulfur levels and mustard varieties on oil content (%).

Level of S/ha	Varieties: Pusa Bold (V_1)	BR-40 (V_2)	Varuna (V_3)	Mean		SE ±	Cd at 5%
S_0	44.29	42.93	44.26	43.82	Levels (L)	0.27	NS
S_{15}	44.72	43.30	44.42	44.15	Varieties (V)	0.27	0.68
S_{30}	45.25	43.56	44.62	44.48	Interaction (L × V)	0.47	NS
S_{45}	45.39	43.91	44.82	44.70	CV %	2.144	
Mean	44.91	43.42	44.53				

more than other levels of sulfur. The progressive increase in oil yield due to different levels of sulfur was 7.46, 21.71 and 35.95% respectively under S_{15}, S_{30}, S_{45} levels as compared to control (S_0). Interaction between level of sulphur and mustard varieties was found significant. The maximum oil yield (418.02 kg/ha) was obtained when BR-40 was fertilized with 45 kg S/ha followed by Pusa bold at 45 kg S/ha (391.26 kg/ha) and Varuna (V_3) at 45 kg S/ha (390.38 kg/ha) (Table 9).

The variety Pusa bold (V_1) gave the maximum mean oil content (44.91%) which was at par with Varuna (V_3), while the minimum oil content (43.42%) was recorded from BR-40 (V_2). The interaction effect between levels of sulfur and varieties was also non-significant. However, Pusa bold at 45 kg S/ha levels recorded the highest oil content 45.39% (Table 10).

Conclusion

The application of sulfur at the rate of 45 kg S/ha was found to be beneficial for yield and quality of mustard crop in Chotanagpur and Santhal Pargana regions. The performance of BR-40 was found to be superior to others two varieties Pusa bold (V_1) and Varuna (V_3).

References

1. Virupakshappa M. and V. Kiresur. 1997. Policy option for plenty. The Hindu surv. Indian agriculture 61—63 pp.
2. Piper C. S. 1950. *Soil and plant analysis.* Inter Serv. Publ. Inc., New York, USA.
3. Jackson M. L. 1973. Soil chemical analysis, Prentice Hall, Pvt. Ltd., New Delhi, India. 263—293 pp.
4. Jackson M. L. 1958. *Soil chemical analysis.* Prentice Hall, New York, USA. 495 pp.
5. Chatterjee B. N., R. K. Ghosh and P. K. Chakarborty. 1985. Response of mustard to sulfur and micronutrients, *Indian J. Agron.* 30 : 75—78.
6. Chaudhary A. K. and J. C. Sharma. 1986. Sulfur for better yield of mustard. *Indian Fmg.* 35 : 12.
7. Mahato S. N. 1990. Sulfur availability in upland and soil of Sighbhum district of Bihar. M. Sc. (Ag). thesis. S. S. A. C., B. A. U. 65—67 pp.
8. Aulakh M. S., N. S. Pasricha and N. S. Sahota. 1980. Yield, nutrient concentration and quality of mustard crop as influence by nitrogen and sulphur fertilizers. *J. Agri. Sci. Camb.* 94 : 545—549.