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RESEARCH ARTICLE

Effect of different levels of sulphur and varieties on growth, yield and quality of Indian mustard

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SUMMARY

Three Indian mustard (*Brassica juncea* L.) cultivars (Kranti, Bio-902 and Rohini) were tested with 4 levels of sulphur (0, 20, 40, 60 kg ha^{-1}) during the winter season of 2006-2007. The variety Rohini gave higher plant height, number of branches/ plant, siliquae/ plant, seeds/siliqua, 1000-grain weight, harvest index and resulted significantly higher seed and stover yield, oil and protein content than Bio-902 and Kranti. The application of 60 kg sulphur per hectare gave significantly higher grain yield and quality (protein and oil content in seed) over all other levels of sulphur application and control.

Key Words : Indian mustard, Sulphur, Yield attributes, Quality

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Brassica are the second most important source of edible oil after groundnut in India and most commonly grown in the indo-gangatic plains. Indian mustard (*Brassica juncea* L.) is an important winter season oilseed crop grown intensively in Uttar Pradesh. Mustard is generally grown on marginal lands with poor fertility gradient. Selection of suitable cultivar and fertilizer management is essential for achieving higher yield. Sulphur is an important constituent of mustard and its deficiency caused a significant reduction in yield and oil content of mustard. Indian soils are becoming deficient in sulphur with passage of time due to intensive cultivation. Continuous removal of sulphur from soils through plant uptake has led to widespread sulphur deficiency and affected soil sulphur budget (Aulakh, 2003) all over the world. Indian mustard responds to sulphur remarkably, depending upon soil type (Arora *et al*., 1994). Singh *et al*. (2000) reported that application of sulphur up to 45 kg ha^{-1} significantly increased the seed yield. Jat *et al.* (2003) concluded that application of 90 kg sulphur per hectare resulted in significantly higher seed and stalk yield. As regards the production of Indian mustard is concerned, its productivity in the Agra region of Uttar Pradesh is very low. Thus, the present investigation was conducted to compare the performance of promising varieties of Indian mustard (*Brassica juncea* L.) in relation to sulphur fertilization.

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MATERIALS AND METHODS

A field experiment was conducted during the winter season of 2006-2007 in factorial randomized block design using three varieties of Indian mustard (Kranti, Bio-902 and Rohini) as a test crop at Agricultural Research Farm of R.B.S. College, Bichpuri, Agra. The surface soil (0-15 cm) samples collected from the experimental farm were analyzed for physico-chemical properties as suggested by Jackson (1973). The soil was well drained, sandy loam in texture having pH

7.9, EC 1.6 dsm^{-1}, organic carbon 4.5 g kg^{-1}, available nitrogen 190.27 kg ha^{-1}, available phosphorus 29.71 kg ha^{-1} and available sulphur 8.3 kg ha^{-1}. NPK was applied at the rate of 80, 60 and 40 kg ha^{-1} and sulphur at the rate of 0, 20, 40 and 60 kg ha^{-1} through urea, diammonium phosphate, muriate of potash and elemental sulphur, respectively. As per treatments, full dose of sulphur was applied as basal dressing along with ½ dose of nitrogen, full dose of phosphorus and potash at the time of sowing and remaining ½ dose of N was applied at 30 days after sowing (DAS). The crop was sown in row (50 cm apart) on 10 November, 2006 and harvested on 14 March, 2007. At maturity yield attributing characters, oil yield and protein content in seed was recorded. The oil content in seed sample was determined by Soxhlet's extraction method. Nitrogen content was determined by micro- Kjeldhal method and protein content was calculated by multiplying the value of N with 6.25.

RESULTS AND DISCUSSION

The data pertaining to the comparative performance of different varieties of mustard under varying levels of sulphur application have been presented in Table 1 to 5 and the results are being discussed as under:

Table 1: Effect of sulphur and varieties on growth characters of Indian mustard

Treatments	Plant height (cm)	Dry matter accumulation plant (g)	Branches/ plants	
			Primary	Secondary
Varieties				
Kranti	172.75	91.59	4.43	5.99
Bio-902	178.23	96.22	4.56	6.57
Rohini	192.75	133.44	5.70	11.26
S.E.±	0.852	1.76	0.072	0.23
C.D. (P=0.05)	2.501	5.16	0.211	0.67
Levels of sulphur (kg/ha)				
0	176.67	97.54	4.62	6.74
20	179.92	104.31	4.83	7.59
40	182.67	110.06	4.92	8.32
60	185.72	116.41	5.21	9.11
S.E.±	0.984	2.03	0.083	0.26
C.D. (P=0.05)	2.888	5.96	0.244	0.78

Table 2: Effect of sulphur and varieties on yield attributing characters of Indian mustard

Treatments	Siliquae /plant	Wt. of siliqua / plant (g)	Seed yield / plant (g)	Length of siliqua (cm)	No. of seeds /siliqua	Test weight (g)
Varieties						
Kranti	195.17	19.65	14.35	4.41	8.88	1.16
Bio-902	204.25	20.17	14.89	4.48	9.10	1.21
Rohini	272.73	20.67	19.62	5.02	11.73	1.59
S.E.±	3.69	0.39	0.23	0.043	0.212	0.037
C.D. (P=0.05)	10.85	NS	0.69	0.12	0.622	0.111
Levels of sulphur (kg/ha)						
0	205.15	19.58	14.95	4.49	9.19	1.21
20	216.09	19.58	15.79	4.58	9.72	1.28
40	236.20	20.67	16.77	4.73	9.78	1.39
60	237.88	20.81	17.62	4.74	10.92	1.40
S.E.±	4.272	0.34	0.27	0.49	0.245	0.043
C.D. (P=0.05)	12.53	1.01	0.80	0.146	0.718	0.128

Table 3: Effect of sulphur and varieties on biological, seed, straw/stalk yield and harvest index of Indian mustard

Treatments	Yield (q/ha)			Harvest index
	Straw/stalk	Seed	Biological	
Varieties				
Kranti	50.13	11.00	69.13	15.73
Bio-902	61.32	12.13	73.45	15.99
Rohini	64.44	14.53	78.97	18.07
S.E.±	0.29	0.06	0.28	0.75
C.D. (P=0.05)	0.86	0.20	0.82	NS
Levels of sulphur (kg/ha)				
0	59.15	11.75	70.98	16.06
20	60.45	12.37	73.66	16.44
40	61.98	12.85	74.64	16.77
60	62.91	13.22	76.13	17.12
S.E.±	0.33	0.08	0.32	0.87
C.D. (P=0.05)	0.99	0.23	0.95	NS

NS=Non-significant

Table 4: Effect of sulphur and varieties on protein and oil content in seed and oil production of Indian mustard

Treatments	Protein in seed (%)	Oil content in seed (%)	Oil production (kg/ha)
Varieties			
Kranti	19.50	38.63	424.90
Bio-902	19.64	38.77	470.03
Rohini	20.64	39.05	577.90
S.E.±	0.087	0.048	2.70
C.D.(P=0.05)	0.258	0.142	8.10
Levels of sulphur (kg/ha)			
0	19.66	38.80	459.51
20	19.81	39.00	487.70
40	20.10	39.17	495.60
60	20.13	39.35	521.34
S.E.±	0.10	0.056	3.20
C.D.(P=0.05)	0.24	0.164	9.40

Table 5: Effect of sulphur and varieties on N content and uptake by seed and stalk of Indian mustard

Treatments	N content (%)		N uptake by seed (kg/ ha)	N uptake by stalk (kg/ ha)	Total N uptake (kg /ha)
	Seed	Stalk			
Varieties					
Kranti	3.12	0.83	34.30	48.40	82.70
Bio-902	3.14	0.84	38.10	51.40	89.50
Rohini	3.30	0.90	48.00	58.10	106.10
S.E.±	0.014	0.004	0.25	0.35	0.33
C.D. (P=0.05)	0.041	0.012	0.75	1.03	0.97
Levels of sulphur (kg/ha)					
0	3.15	0.84	37.30	49.70	87.00
20	3.17	0.85	39.80	52.2	92.00
40	3.22	0.86	40.80	53.4	94.00
60	3.22	0.88	42.70	55.2	97.90
S.E.±	0.016	0.004	0.29	0.40	0.38
C.D. (P=0.05)	0.047	0.014	0.86	1.18	1.12

Effect of varieties :

Growth parameters such as plant height, number of primary and secondary branches/ plant and dry matter accumulation/plant of Indian mustard were significantly influenced by different varieties of Indian mustard. Maximum plant height, number of primary and secondary branches/ plant and dry matter accumulation/plant of Indian mustard were observed with Rohini variety which were significantly higher than Kranti and Bio-902. The yield attributing characters were significantly affected by different varieties. Siliquae/ plant, weight of siliqua/plant, seed yield/ plant, seeds/ siliqua, length of siliqua (cm) and 1000-grain weight were maximum in Rohini variety as compared to Kranti and Bio-902. The variety Rohini had 31.40 and 38.69 per cent more weight of 1000 seeds over Bio-902 and Kranti. Among Indian mustard varieties, Rohini gave significantly higher total biological, grain and straw yield and harvest index as compared to Kranti and Bio-902. Similar, results were found by Singh *et al*. (2002). Rohini variety recorded significantly higher oil content and yield as well as protein contents which was significantly superior to bio-902 and Kranti. The variety Rohini produced 38.63 and 38.77 kg/ ha more oil yield over Bio-902 and Kranti, respectively. Similar, results were also obtained by Mohan and Sharma (1992). Maximum nitrogen content and uptake by stalk and grain was observed with Rohini variety as compared to Kranti and Bio-902. Total nitrogen uptake by stalk and grain was also observed with Rohini variety as compared to Kranti and Bio-902. This may be due to higher production of Rohini variety.

Effect of levels of sulphur :

Growth parameters such as plant height, number of primary and secondary branches/ plant and dry matter accumulation/plant of Indian mustard were significantly influenced by different levels of sulphur. Plant height, number of primary and secondary branches/ plant and dry matter accumulation/plant of Indian mustard increased significantly with each increasing levels of sulphur from 0 to 60 kg/ha. The yield attributing characters were significantly affected with different levels of sulphur. Siliquae/ plant, weight of siliqua/ plant, seed yield/ plant, seeds/ siliqua, length of siliqua (cm) and 1000-grain weight were maximum with 60 kg/ha sulphur as compared to preceding lower levels (0, 20 and 40 kg/ha.) Total biological, grain and straw yield and harvest index were significantly affected with different levels of sulphur. Sixty kg/ha sulphur gave significantly higher total biological, grain and straw yield and harvest index as compared to 0, 20 and 40 kg/ha sulphur. Maximum grain yield with sixty kg/ha sulphur was mainly due to more siliquae/ plant, weight of siliqua/ plant, seed yield/ plant, seeds/ siliqua, length of siliqua (cm) and 1000-grain weight as compared to lower doses. Moreover, increment in seed yield was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism as influenced by sulphur application. Similar, results were reported by Rathore and Manohar (1990). Sixty kg/ha sulphur recorded significantly higher oil content and yield as well as protein contents as compared to lower levels (0, 20 and 40 kg/ha). Increase in oil content was mainly due to an increase in glucoside formation (Singh and Singh, 1977). Higher sulphur utilization by crop with adequate supply of sulphur enhanced the protein synthesis in plant and ultimately increased the protein content in mustard. Oil content in seed increased with increasing levels of sulphur and increase in oil yield was also recorded with increasing sulphur levels. This was due to combined effect of oil content and oil yield of mustard. Similar, results were reported by Dubey and Khan (1993). Maximum nitrogen content and uptake by stalk and grain was observed with 60 kg/ha as compared to lower levels (0, 20 and 40 kg/ha). Total nitrogen uptake by stalk and grain was also observed with 60 kg/ha as compared to lower levels (0, 20 and 40 kg/ha). This may be due to higher production with 60 kg/ha.

Conclusion :

On the basis of aforesaid findings, it could be concluded that sulphur @60 kg/ha- and variety 'Rohini' improved productivity and quality of Indian mustard and this combination was the best treatment as compared to others. There is a need to verify the results in multi-location trials across the country following diverse soil and climatic conditions.

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