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Impact of Sulphur Nutrition on Promising Mustard Cultivars in Eastern Uttar Pradesh

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ABSTRACT

A field experiment was conducted during the rabi seasons of 2010-11and 2011-12 to assess the Impact of sulphur nutrition on promising mustard cultivars in eastern Uttar Pradesh. The experiment was conducted with randomized block design and replicated three times. Twelve treatment combinations consisted of four sulphur levels viz., S_0 (0 kg S ha^{-1}), S_1 (20 kg S ha^{-1}), S_2 (40 kg S ha^{-1}) and S_3 (60 kg S ha^{-1}) and three varieties viz., V_1 (Varuna), V_2 (Rohini) and V_3 (Narendra Rai -8501) were allocated randomly. Results revealed that all the growth, yield attributes and quality were increased significantly under 60 kg S ha^{-1}. The growth characters viz., plant height, leaf area index, dry matter accumulation and number of branches plant^{-1} and yield attributes like number of siliqua plant^{-1}, number of seed siliqua^{-1}, length of siliqua (cm) and seed and stover yields of mustard crop were significantly higher with Narendra Rai-8501 as compared to Varuna and Rohini. The highest net return and B:C ratio were computed under 60 kg S ha^{-1} with Narendra Rai-8501. Mustard variety Narendra Rai 8501 at 60 kg sulphur ha^{-1} proved most remunerative and economically feasible for cultivation under the agroclimatic condition of eastern Uttar Pradesh.

Key words: *Sulphur levels, Varieties, Growth, Yield attributes, Quality and Economics.*

INTRODUCTION

Mustard is the second most important edible oil-seed crop after groundnut. It plays an important role in the oil-seed economy of the country. India occupies the third position in mustard production in World after China and Canada. In India, during 2009-2010, the mustard crop had production of about 6.40 m t from an area of 6.45 m ha with an average productivity of 1184 kg ha^{-1}. However, in U.P it is grown in 0.82 m ha with production of 0.90 m t. The average productivity in U.P is 1141 kg ha^{-1}, which is 3.6% lower than the national average productivity[1].

Improved plant types play an important role in raising the seed yield of the crops. Development of high yielding varieties of mustard has been one of the major concerns of the scientists because use of the improved varieties alone accounts for 15-20 per cent increase in productivity.

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This is probably because of their altered morphology which results into efficient utilization of water, nutrients and solar radiation.

Indian mustard markedly responded to sulphur fertilization in oilseeds, sulphur plays a vital role in quality and development of seed. The importance of sulphur fertilization for increasing yield and quality of Indian mustard is being increasingly recognized. However, the information regarding optimum level of sulphur and its influences on seed yield and quality of different varieties of mustard is meager. Probably for these reasons mustard crop needs comparatively higher amount of sulphur for proper growth and development and higher yields.

Sulphur is considered to occupy fourth place among major plant nutrient after nitrogen, phosphorus and potassium[2]. It increases phosphorus uptake by plant[3] and nitrogen in protein synthesis and is indispensable for the synthesis of essential amino acid like cysteine and methionine. Besides, sulphur is also involved in various metabolic processes of plants. It is a constituent of glutathione, a compound supposed to be associated with the plant respiration and the synthesis of essential oils. Sulphur also plays a vital role in chlorophyll formation.

The present production is not adequate to meet the edible oil requirement of our fast growing population. A wide gap exists between the demand and supply resulting into a large scale import of fats and oils at the expense of valuable foreign exchange rapeseed-mustard is the most important rabi oilseed crop of Northern India grown mainly for edible oil requirement of our fast growing population, the efforts should be made to increase the production of oilseed crops. Rapeseed-mustard gives good response to sulphur.

MATERIALS AND METHODS

The experiment was conducted at Agronomy Research Farm of N.D. University of Agriculture & Technology, Faizabad (U.P.) during *rabi* seasons of 2010-11 and 2011-12. Geographically experimental site is situated at 26^0 47′ N latitude; 82^0 12′ E longitude and an altitude of 113 m above MSL in the Indo-Gangetic regions of Eastern U.P. Soil of the experimental site was silt loam, having 0.32% organic carbon, 136.5 kg/ha available N, 14.5 kg/ha available P_2O_5, 248.5 kg/ha available K_2O, 6.8 kg/ha available S, 8.2 pH and 0.34 dsm^{-1}EC. The experiment was conducted in a randomized block design replicated there times. Twelve treatment combinations consisted of four sulphur levels *viz.,* S_0 (0 kg S ha^{-1}), S_1 (20 kg S ha^{-1}), S_2 (40 kg S ha^{-1}) and S_3 (60 kg S ha^{-1}) and three varieties *viz.,* V_1 (Varuna), V_2 (Rohini) and V_3 (Narendra Rai - 8501) were allocated randomly. Seeds were sown at 45 cm spacing with the help of *deshi* plough. Thinning was done in two phases. In the first phase dense emerging seedling were uprooted after 10 days of sowing. Second phase of thinning was completed by maintaining plant to plant and row to row distance after 10 days of first thining.

RESULTS AND DISCUSSION

Growth characters

Sulphur levels had significant effect on plant height, leaf area index, dry matter accumulation $plant^{-1}$ and number of branches $plant^{-1}$ at harvest of mustard crop. Plant height, leaf area index, dry matter accumulation $plant^{-1}$ and number of branches $plant^{-1}$ increased successively with increasing the levels of sulphur up to 60 kg ha^{-1}. Significantly higher plant height, leaf area index, dry matter accumulation $plant^{-1}$ and number of branches $plant^{-1}$ were recorded under 60 kg sulphur ha^{-1} which was at par with 20 and 40 kg sulphur ha^{-1} and significantly superior over control. The increase in plant height, leaf area index, dry matter accumulation $plant^{-1}$ and number of branches $plant^{-1}$ due to adequate availability of sulphur attributes to better nutritional environment for plant growth at active vegetative stage as a result of enhancement in cell multiplications, cell elongation and cell expression in the plant body which ultimately increased the height of plant, leaf area index

and number of branches plant^{-1}. Increase in number of branches plant^{-1}, plant height and leaf area index is directly responsible for increasing the dry matter accumulation in plants at higher levels of sulphur. The results of present investigation are also in agreement with the findings of Kumar[4] and Singh[5].

Almost all the growth characters *viz.*, plant height, leaf area index, dry matter production and number of branches plant^{-1} were significantly higher with variety Narendra Rai-8501 as compared to Rohini and Varuna at all the growth stages except 30 DAS. This may be due to genetical behavior of the variety which showed greater photosynthetic efficacy and its translocation to growing points which results faster growth and development. Singh[5] also reported that growth parameters such as plant height, number of branches plant^{-1} of Narendra Rai-8501 were significantly higher than Varuna.

Yield attributes

All the yield attributes *viz.,* siliquae plant^{-1}, siliqua length and number of seeds siliqua^{-1} increased with increasing in dose of sulphur upto 60 kg sulphur ha^{-1} which was significantly superior over control but at par with 20 and 40 kg sulphur ha^{-1}. Increase in value of these yield contributing characters with higher dose of sulphur was due to facts the adequate sulphur was available during the entire period of crop growth for better vegetative growth and development of mustard plants. The beneficial effects have been also reported by Singh[6].

The maximum values of all the yield attributes such as siliqua plant^{-1}, siliqua length, seed siliqua^{-1}, yield plant^{-1} and 1000-seed weight were significantly higher with variety Narendra Rai-8501 as compare to Rohini and Varuna. It might be due to increase the direct involvement of number of branches, consequent effect of fertilization and greatly influenced by the compatibility of the pollen grains. Superiority of varieties on number of seeds siliqua^{-1} may be due to greater production of pollen grains and their efficient use of fertilization. Varieties differences in Indian mustard in respect to yield attributes were also observed by Singh[5].

Yield

The variation in seed yield and stover yield are the results of variation in various growth and yield contributing characters and hence productivity of mustard is collectively determined by vigourness in the vegetative growth and increase in value of various yield attributes. The higher number of siliqua plant^{-1}, length of siliqua, number of seed siliqua^{-1} and 1000-seed weight resulted into higher seed yield of mustard. The seed yield and stover yield of mustard were significantly increased with increasing dose of sulphur upto 60 kg sulphur ha^{-1} which was at par with 20 and 40 kg sulphur ha^{-1} and significantly superior over control. The increase in seed yield under adequate sulphur supply might be due to higher number of siliqua plant^{-1}, more number of seeds siliqua^{-1} and higher 1000-seed weight, which was result of better translocation of photosynthates from source to sink. Sulphur also stimulates the seed setting, seed formation and oil synthesis in the seed of mustard and it increases the seed and stover yield of mustard. Rana[7] also reported the similar result.

Yield is the result of coordinated inter play of growth and development traits. Cumulative response of growth and yield attributes to determine the yield. Seed and stover yield were highly responded to varieties. The maximum seed and stover yield were recorded in Narendra Rai-8501 and it was mainly due to enhanced rate of photosynthesis and carbohydrate metabolism. The higher stover yield was due to difference in varieties that is better partitioning of photosynthates towards seed leading to more seed yield *vis-a-vis* harvest index. The varietal differences in Indian mustard with respect to seed and stover yield were also observed by Yadav[8] and Singh[5].

Quality

The higher oil content in seed was recorded with the application of 60 kg sulphur ha^{-1}, which was significantly superior over control and at par with 20 and 40 kg sulphur ha^{-1}. This was probably due to the facts that the sulphur is a constituent of lipids and it is also essential for the synthesis of lipids. Therefore, higher

levels of sulphur increased the oil content in mustard. Similar results were also obtained by Issa[9] and Singh[5].

Protein content was not influenced significantly by sulphur though there was an increase of 1% with sulphur application. It could be due to higher nitrogen utilization by crop plants under adequate supply of sulphur, which enhanced the protein synthesis in plants and ultimately increased the protein content in seeds of mustard since sulphur is also a constituent of amino acids. Sulphur also provides disulphide (-S-S) bond for cross linkage in to two polypeptides chain and it helps in formation of protein. The increase in protein content with sulphur application was also reported by Kumar[10].

Oil and protein content was greatly influenced by the varieties. The protein content of Narendra Rai-8501 was significantly higher over Varuna and Rohini. The maximum oil content was found in Narendra Rai-8501 which was significantly higher over Varuna and Rohini. This rise may be due to genetic characters of various varieties. This result are enclose accordance those of Singh[5].

Economics

The highest net income was obtained at 60 kg sulphur ha^{-1} with Narendra Rai-8501 variety followed by 40 kg sulphur ha^{-1} with same variety. The highest net return $rupee^{-1}$ investment were obtained at 60 kg sulphur ha^{-1} with Narendra Rai-8501 followed by 40 kg sulphur ha^{-1} with same variety. The variation in cost of cultivation was recorded due to variation in sulphur doses. Similar results have been also found by Kumar[11].

Table1: Growth and Yield attributes as influenced by sulphur levels and varieties of mustard (averaged over 2 years)

Treatment	Plant height (cm) at harvest	Leaf area index at 90 DAS	Dry matter accumulation (g) $plant^{-1}$ at harvest	Number of branches $plant^{-1}$ at harvest	Number of siliqua $plant^{-1}$	Length of siliqua (cm)	Number of seed $siliqua^{-1}$	Test weight (g)
Sulphur levels (kg ha^{-1})								
S_0	124.64	3.73	117.47	20.82	217.23	5.91	12.15	4.58
S_{20}	136.43	4.08	128.58	22.79	237.78	6.63	13.30	4.66
S_{40}	144.27	4.32	135.99	24.67	251.48	6.84	14.07	4.67
S_{60}	147.66	4.42	139.16	24.67	257.35	7.00	14.39	4.70
SEm±	4.74	0.14	4.47	0.79	8.26	0.23	0.45	0.16
CD (P=0.5%)	13.93	0.42	13.13	2.33	24.27	0.68	1.32	N.S
Varieties								
Varuna (V_1)	136.85	4.09	128.98	22.86	238.52	6.49	13.34	4.63
Rohini (V_2)	129.27	3.87	121.83	21.60	225.31	6.13	12.60	4.61
Narendra Rai (V_3)	148.64	4.45	140.09	24.83	259.07	7.05	14.49	4.72
SEm±	4.10	0.12	3.87	0.69	7.15	0.20	0.39	0.13
CD (P=0.5%)	12.06	0.36	11.37	2.02	21.02	0.59	1.15	N.S

Table 2: Yield and quality as influenced by sulphur levels and varieties of mustard (averaged over 2 years)

Treatment	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Oil content in seed (%)	Protein content in seed (%)
Sulphur levels (kg ha^{-1})				
S_0	12.25	43.03	32.66	21.18
S_{20}	13.41	47.10	35.75	21.26
S_{40}	14.19	49.82	37.80	21.94
S_{60}	14.52	50.98	38.69	22.19
SEm±	0.47	1.77	1.12	0.73
CD (P=0.5%)	1.37	5.20	3.30	N.S
Varieties				
Varuna (V_1)	13.46	47.25	35.86	21.53
Rohini (V_2)	12.71	44.63	33.87	20.71
Narendra Rai (V_3)	14.61	51.32	38.94	22.68
SEm±	0.40	1.53	0.97	0.63
CD (P=0.5%)	1.19	4.50	2.86	N.S

Table 3: Economic of various treatment combinations in mustard (averaged over 2 years)

Treatment combination	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
V_1S_0	20519	46747	26228	1.28
V_1S_{20}	21995	51174	29179	1.33
V_1S_{40}	24071	53081	29010	1.21
V_1S_{60}	25847	54340	28493	1.10
V_2S_0	20519	44228	23709	1.16
V_2S_{20}	21995	47394	25399	1.15
V_2S_{40}	24071	50561	26490	1.10
V_2S_{60}	25847	51821	25974	1.00
V_3S_0	20519	47709	27190	1.32
V_3S_{20}	21995	52980	30985	1.40
V_3S_{40}	24071	58267	34196	1.42
V_3S_{60}	25847	63456	37530	1.45

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