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Response of Sulphur Application on Growth, Yield, Content and Uptake by Indian Mustard (*Brassica juncea* L.) in *Inceptisols*

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ABSTRACT

Field experiment was conducted at Instructional Farm, Krishi Vigyan Kendra, Raigarh (CG), during *rabi* 2019-20 to investigate the response of sulphur application on growth, yield, sulphur content and uptake by Indian mustard (*Brassica juncea* L.) in *Inceptisols*. The experiment was laid out in Randomized Block Design (RBD) comprising six treatments with three replications. It was observed that increasing sulphur application increases the growth and yield attributes i.e. plant height, no. of siliqua plant^{-1}, no. of seeds siliqua^{-1}, seed yield and stover yield was obtained with T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)]. The results revealed that significantly increased in the sulphur content and uptake was found up to T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)].

Keywords Sulphur, Growth, Yield, Nutrient content, Uptake.

INTRODUCTION

Rapeseed-mustard is the third most important edible oilseed crop in India. It occupies about 24.70% of area and 48.28% of production of the total oilseed production in country. In India rapeseed- mustard production was recorded 72.41 mt in 2018-19 (Anonymous 2020b) that accounts 12.1% share of the global oilseed production 597.27 mt. India mustard occupies one fifth of global area and one tenth of production. During 2008-09 to 2018-19 rapeseed-mustard production increased up to 28.6%. In the country area and production is fluctuating and it was 6.30 mha and 7.20 mt respectively in 2008-09, while it was 6.12 mha and 9.26 mt respectively in 2018-19 (Anonymous 2019a, 2020a). Mustard seed and oil are used in the preparation of pickles and for flavoring curries and vegetables. The young plant leaves are used as green vegetables and provided adequate sulphur mineral in the diet. Mustard oil is also used for preparation of hair oil and medicine. Mustard oil cakes used as feed for cattle and manure. They are not only rich sources of energy and carriers of fat soluble vitamins,, A, ‟,,D,‟,,E‟ and ,,K‟ but they form the ingredients of foods and flavors, cosmetics and con-

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Table 1. Sulphur fertilizer prescriptions based on available sulphur status of soils. Source : Patel *et al.* (2001).

Available S in soil (mg kg^{-1})	S fertility class	Increase in yield (%)	Soil deficiency class	Prescription of S fertilizer (kg ha^{-1})		
				Cereal	Oilseeds	Pulses
<5	Very low	25-85	Very high	60	40	30
5-10	Low	20-50	High	45	30	20
10-15	Medium	5-20	Moderate	30	20	15
15-20	High	1-5	Low	15	10	10
>20	Very high	0	Very low	0	0	0

diments, soap and detergents, lubricants and laxatives and also known for their medical and therapeutic use.

Sulphur (S) is one of the essential plant nutrient required for the growth, metabolism and development of all plants. Sulfur plays a vital role in various physiological and biochemical functions in plants. Plant absorbs sulphur in the form of sulfate ions (SO_4^{-2}). Sulphur is involved in formation of chlorophyll and activation of the enzyme sulphydryl (SH). Because it is directly involved in synthesis of sulphur containing amino acids like methionine, cystine and cysteine. Mustard oil has pungency due to presence of sulphur compound glucosinolates and glucosides. Sulphur application significantly influenced the seed and stover yield of mustard (Sharma *et al.* 2009). Sulphur is also important element which increases yield attributes resultantly the yield of Indian mustard (Kumar *et al.* 2011) and also enhanced S uptake as well as oil content (Singh and Pal 2011 and Kumar and Trivedi 2012). Application of sulphur was reported to increase yield attributes and yield of Indian mustard (Patel *et al.* 2009, Kumar *et al.* 2011). Oilseeds (Brassica species/cultivars) vary in their sensitivity to sulphur deficiency and S requirement for optimum seed yield and quality (Malhi *et al.* 2005). Sulphur deficiency results in accumulation of amides and carbohydrates and in turn, retards the formation of chlorophyll and causes stunted plant growth and pale green coloration of young leaves. The importance of sulphur fertilization for increasing yield and oil quality of Indian mustard. However, the information regarding optimum level of sulphur and its influences on seed yield and oil quality. Mustard crop needs comparatively higher amount of sulphur for proper growth and development and higher yields. Sulphur requirement is the highest for oilseed crop followed by pulses and least for cereals. The Sulphur fertilizer prescriptions based on available sulphur status of soils depicted in Table 1.

MATERIALS AND METHODS

Field experiment was conducted at during *rabi* 2021-22 to investigate the response of sulphur application on growth, yield, sulphur content and uptake by Indian

Table 2. Effect of sulphur on growth and yield of mustard.

Treatments	Plant height at maturity (cm)	No. of siliqua $plant^{-1}$	No. of seeds $siliqua^{-1}$	Mustard yields (kg ha^{-1})	
				Seed	Stover
T_1 [RDF (100:80:40:0 kg ha^{-1} NPKS)]	128.10	213.33	10.20	1067.60	2818.46
T_2 [RDF (100:80:40:10 kg ha^{-1} NPKS)]	136.67	227.67	10.60	1255.50	3301.96
T_3 [RDF (100:80:40:20 kg ha^{-1} NPKS)]	138.42	229.67	10.70	1430.25	3754.40
T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)]	140.55	238.33	10.80	1545.30	4087.31
T_5 [RDF (100:80:40:40 kg ha^{-1} NPKS)]	140.80	238.33	11.10	1562.65	4109.76
T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)]	141.33	239.67	11.30	1585.32	4175.73
SEm±	0.19	0.03	0.51	0.35	103
CD (0.05)	0.56	0.08	NS	1.03	283

Table 3. Effect of sulphur on content and uptake of mustard.

Treatments	Sulphur content (%)		Sulphur uptake (kg ha^{-1})		Total sulphur uptake (kg ha^{-1})
	Seed	Stover	Seed	Stover	
T_1 [RDF (100:80:40:0 kg ha^{-1} NPKS)]	0.40	0.18	4.27	5.07	9.34
T_2 [RDF (100:80:40:10 kg ha^{-1} NPKS)]	0.42	0.21	5.39	6.93	12.32
T_3 [RDF (100:80:40:20 kg ha^{-1} NPKS)]	0.45	0.27	6.43	10.13	16.56
T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)]	0.48	0.31	7.41	12.67	20.08
T_5 [RDF (100:80:40:40 kg ha^{-1} NPKS)]	0.49	0.33	7.65	13.56	21.22
T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)]	0.51	0.36	8.08	15.03	23.11
SEm±	0.01	0.01	0.59	1.11	1.29
CD (0.05)	0.03	0.03	1.62	3.05	3.56

mustard (*Brassica juncea* L.) in *Inceptisols* at Instructional Farm, Krishi Vigyan Kendra, Raigarh (C.G.). The experimental site is located on the northern part of Chhattisgarh state and lies at 21°54'N latitude and 83°24' E longitude with an altitude of 215 m above the mean sea level (MSL). The soil of the experimental field was an *Inceptisols* of silty clay loam texture with pH 6.50, EC 0.13 dSm^{-1}, organic carbon (OC) 5.0 g kg^{-1}, available nitrogen 210 kg ha^{-1}, available phosphorus 20.83 kg ha^{-1}, available potash 295 kg ha^{-1} and available sulphur 20.53 kg ha^{-1}. The experiment was laid out in Randomized Block Design (RBD) comprising six treatments i.e. T_1 [RDF (100:80:40:0 kg ha^{-1} NPKS)] Control, T_2 [RDF (100:80:40:10 kg ha^{-1} NPKS)], T_3 [RDF (100:80:40:20 kg ha^{-1} NPKS)], T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)], T_5 [RDF (100:80:40:40 kg ha^{-1} NPKS)], T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)] with replicated three times. The 50% of N and full dose of P_2O_5, K_2O and sulphur was applied as basal dose. Remaining 50% dose of N is applied as twice top dressing. Cultural practices such as weeding, plant protection measures, were done. The crop variety was Chhattisgarh Sarson used as a test crop. Five plants were selected randomly from each plot for sampling purposes and observations were recorded. The data regarding growth characters, yield attributes and yield were analyzed with statistical tools applied and when required for the study.

RESULTS AND DISCUSSION

Growth and yield attributes

The data revealed that significant differences were observed in growth and yield attributes with all treatments depicted in Table 2. The maximum plant height (141.33 cm) and no. siliqua plant^{-1} (239.67) was recorded with T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)] which was significantly superior with all the treatments over control. The no. of seeds siliqua^{-1} had no significant response to different treatments. Sulphur fertilization increasing the seed yield which might be supplemented with increased number of siliquae/plant (Patel *et al.* 2009) and seeds/siliqua (Kumar *et al.* 2011). This is might be due to more synthesis of amino acids increase in chlorophyll content in growing regions, meristematic tissues due to sulphur application, ultimately enhancing cell division and thereby increased crop growth.

The seed and stover yields of mustard increased significantly with all the treatments over control. The maximum seed yield (1585.32 kg ha^{-1}) and stover yield (4175.73 kg ha^{-1}) were recorded with T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)]. The variation in yields were observed due to variation in treatment combinations. Significant response of sulphur application was observed up to the 30 kg ha^{-1}. The increment in seed and stover yields might be due to improvement in soil quality with sulphur application instant availability of nutrients from inorganic fertilizers. These finding are also reported by Chandra and Ram (2007) and Saha *et al*. (2010). The enhancement of seed yield in mustard due to the sulphur application had also been reported by Kumar and Trivedi (2012). Sulphur application resulted acidifying effects and regulates pH and augments the availability of nutrients and offers resistance to plants against drought, pest and diseases.

This improvement might be due to the translocation of photosynthesis leading to improvement of higher yields.

Sulphur content and uptake

The data revealed that sulphur content in seed and stover, sulphur uptake by seed and stover as well as total uptake of sulphur significantly influenced by sulphur application depicted in Table 3. Sulphur content in seed and stover varied from 0.40 to 0.51 and 0.18 to 0.36% respectively. Application of increasing levels of sulphur significantly increased sulphur concentration in seed and stover with T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)]. This was mainly due to greater availability of sulphur in soil, increased the S concentration. The increase in sulphur concentration was also reported by Singh and Singh (2007), Neha *et al.* (2014) and Singh and Thenua (2016).

The application of sulphur increase uptake by seed and stover of mustard with all the treatments. The maximum uptake by seed (8.08 kg ha^{-1}) and by stover (15.03 kg ha^{-1}) were recorded with T_6 [RDF (100:80:40:50 kg ha^{-1} NPKS)]. There was significant increase in sulphur uptake by seed and stover with T_4 [RDF (100:80:40:30 kg ha^{-1} NPKS)] mainly due to the better nutrition, which resulted in better growth and yield, ultimately in higher uptake of nutrients. Increased uptake of sulphur by mustard with sulphur treatment might be assign due to increase in seed and stover yields and increase sulphur content of seed and stover which in term enhanced the uptake (Pachauri *et al.* 2012, Rai *et al.* 2014 and Singh and Thenua 2016. The trends of variation of uptake under different treatments were almost similar to sulphur concentration in seed and stover. The increased uptake of sulphur may also due to mutually competitive effect of adsorption sites and resultant increase in sulphur concentration in soil solution.

The sulphur fertilization increasing yield and oil quality of Indian mustard. However, the optimum level of sulphur and its influences on seed yield and oil quality. Indian mustard needs comparatively higher amount of sulphur for proper growth and development and higher yields. Sulphur requirement is higher of oilseed crop followed by pulses and least for cereals. The Sulphur fertilizer prescriptions based on available sulphur status of soils depicted in Table 1.

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