Annals of Plant and Soil Research 22(2): 123- 127 (2020)

Effect of sulphur and boron on yield, quality and uptake of nutrients by mustard (*Brassica juncea*) grown on alluvial soil

RANJEET SINGH, HAR MOHAN SINGH YADAV* AND VINAY SINGH

Department of Agricultural Chemistry & Soil Science Raja Balwant Singh College, Bichpuri, Agra (U.P.) 283 105

Received: February, 2020; Revised accepted: April, 2020

ABSTRACT

A field experiment was conducted at farmers' field at Panwari village in Agra district of Uttar Pradesh during rabi season of 2015-16 and 2016-17 to study the response of Indian mustard (Brassica Juncea (L) Czernj & Cosson) to sulphur and boron. Nine treatments were evaluated in randomized block design with three replications. The results revealed that the highest growth and yield attributes were recorderd with 40kg S + 2kg B ha^{-1}, which were statistically at par with 40kg S + 1kg B ha^{-1} but significantly superior to other treatments. Similarly, maximum seed (2.38 t ha^{-1}) and stover (6.82 t ha^{-1}) yields were recorded with 40kg S + 2kg B ha^{-1} resulting in 28.6 and 27.7% increase in seed and stover yield, respectively over recommended dose of fertilizers. The mean protein (20.2%) and oil (41.6%) contents were highest in the treatment having 40 kg S + 2 kg B ha^{-1}. The uptake of nitrogen by seed and stover of mustard increased with S and B application and maximum values of N uptake by seed (73.1 kg ha^{-1}) and stover (51.5 kg ha^{-1}) were recorded with 40 kg S+2 kg B ha^{-1}. The maximum utilization of phosphorus by the crop was recorded with 40kg S + 2kg B ha^{-1}. The uptake of S and B by the crop increased significantly with increasing their levels and maximum values were recorded with 40kg S + 2kg B ha^{-1}. The minimum values of uptake of nitrogen, phosphorus, sulphur and boron by the crop were recorded under recommended dose of fertilizers. The available S and B contents in post harvest soils were reduced in the plots having no B and S fertilization. The combined application S and B at higher levels resulted in higher status of available S (23.0 kg ha^{-1}) and B (0.35mgkg^{-1}) in post harvest soil.

Keywords: Mustard crop, quality, nutrient uptake, sulphur, boron, yield

INTRODUCTION

Mustard (*Brassica Juncea* L) is the second most important oilseed crop contributing nearly 25 to 30% of the total oilseed production in the country. Optimum nutrition is required for getting maximum seed yield and good quality of the seed. Sulphur and boron play an important role in the production phenology of oil seed crops and these crops respond well to applied S and B (Singh *et al.* 2017). Sulphur is considered to be the fourth important essential nutrient after nitrogen, Phosphorus and potassium for the plant growth. Sulphur is a constituent of some important amino acids namely cystine, cysteine and methionine. It is necessary for chlorophyll formation and helps in synthesis of oil. It is also responsible for synthesis of certain vitamins (B, biotin and thiamine), metabolism of carbohydrates, proteins and oil formation of flavour compounds in crucifers brassica has the highest sulphur requirement owing to the presence of sulphur rich glucosinolates. Boron is involved in the transportation of sugar, cell membrane and flower fertility and in the synthesis of cell wall material. It influences transpiration through the control of sugar and starch formation. It also influences cell development and elongation. The quality of seed deteriorated with low B as reflected in decreased content of starch, protein and oil along with stimulated concentrations of sugars and phenols. Due to increased cropping intensity the deficiency of S and B is common in oilseed crops. In S and B deficient soils, generally all crops response to sulphur and boron application, but in case of oilseeds the response is higher since there is paucity of information on oilseeds to S and B in alluvial soils of Agra region of Uttar Pradesh. The present investigation was carried out to study the response of sulphur and boron levels on yield attributes, yield and uptake of nutrients by Indian mustard.

MATERIALS AND METHODS

A field experiment was conducted for two consecutive years (2015-17) at farmer field at Panwari village of Agra district, Uttar Pradesh. The experimental soil had pH 8.1, organic carbon 3.2 g kg^{-1} available N 175 kg ha^{-1}, available S 16.5 kg ha^{-1} and available B 0.25 mgkg^{-1}. The experiment was conducted in

Shri Megh Singh Mahavidyalay, Abidgarh, Agra

randomized block design with nine treatments replicated three times. The treatments were T_1 recommended dose of NPK fertilizers (RDF), T_2 RDF + 20 kg S ha^{-1}, T_3 RDF + 40 kg S ha^{-1}, T_4 RDF + 1 kg B ha^{-1}, T_5 RDF + 2 kg B ha^{-1}, T_6 RDF + 20 kg S + 1 kg B ha^{-1}, T_7 RDF + 20 kg S + 2 kg B ha^{-1}, T_8 RDF + 40 kg S + 1 kg B ha^{-1} and T_9 RDF + 40 kg S + 2 kg B ha^{-1}. Mustard variety Bio 902 was taken as test crop. Recommended dose of 100, 60 and 40 Kg ha^{-1} of N, P_2O_5 and K_2O were applied through urea, diammonium phosphate and muriate of potash, respectively. Source of S and B were elemental sulphur and borax (10.5%), respectively. Half dose of N and full dose of P, K, S and B were applied at sowing as basal while remaining dose of N was applied at the time of first irrigation. The crop was harvested at physiological maturity and yields (seed and stover) were recorded. The seed and stover samples were digested in a di acid mixture (HNO_3, $HCLO_4$ 4:1), Phosphorus, sulphur and B were analysed by molybdo-vanadate yellow colour method (Jackson 1973), turbidimetric method (Chesnin and Yien 1951) and B by using azomethine-H (John etal 1975), respectively. Nitrogen in seed and stover was determined by adopting Kjeldahl method and protein content was obtained by multiplying with the factor of 6.25. Oil content in seed was determined by using Soxhlet apparatus. The soil samples collected after harvest of the crop were analysed for available S (Chesnin and Yien 1951) and available B (John etal1975). The data gathered in each observation were statistically evaluated using analysis of variance (ANOVA) techique (Panse and Sukhatme 1985). The critical difference (CD) was computed to assess the significance of treatment means at 5% level of probability.

RESULTS AND DISCUSSION

Yield attributes and yield

A Critical persual of the data (Table1) would reveal that the levels of S and B application singly or in combination had resulted in an increase in yield attributes of mustard crop over recommended dose of fertilizers. The tallest plant (171.0cm) were recorded with 40 kg S and 2 kg B ha^{-1} and proved significantly superior to recommended dose of fertilizers. Application of sulphur and boron might have increased the availability of S and B in deficient alluvial soil which favoured better utilisation of nutrients by the crops. Similar results were reported by Singh *et al.* (2017). Application of 40 kg S along with 2 kg B ha^{-1} had resulted significantly higher number of siliquae per plant (163.5). The lowest number of siliquae (149.4) per plant was recorded with recommended dose of fertilizers (T_1). Increase in number of siliquae per plant with addition of S and B might be due to increase in S and B concentration in soil solution which is favourable in translocation of photosynthates. The seeds per siliqua increased significantly with application of sulphur and boron either singly or in combination. Application of 40 kg S and 2kg B ha^{-1} recorded higher number of seeds per siliqua (15.1) which was statistically at par with 40 kg S+1 kg B ha^{-1} (15.0). The increase in number of seeds per siliqua might be due to pivotal role in synthesis of amino acid and protein with S and B addition. Similar results were reported by Jaiswal *et al.*(2015).Application of sulphur and boron manifested their significant beneficial influence on test weight. The maximum value of test weight (5.2g) was recorded with 40 kg S + 2

Table1: Effect of sulphur and boron levels on yield attributes and yield of Mustard (mean of 2 years

Treatment	Plant height (cm)	Siliquae $plant^{-1}$	Seed $Siliquae^{-1}$	Test weight (g)	Seed yield (t ha^{-1})	Stover yield (t ha^{-1})	Oil content (%)	Protein content (%)
T_1 RDF	155.0	149.4	14.4	4.7	1.85	5.34	38.4	18.4
T_2 RDF+20 Kg S ha^{-1}	161.2	154.1	14.7	4.9	2.10	5.80	39.9	18.7
T_3 RDF+40 Kg S ha^{-1}	166.5	158.5	14.9	5.0	2.28	6.46	40.7	18.9
T_4 RDF+1 Kg B ha^{-1}	158.0	152.6	14.6	4.8	1.99	5.67	39.8	19.0
T_5 RDF+2 Kg B ha^{-1}	162.4	155.0	14.7	4.9	2.10	5.98	40.1	19.1
T_6 RDF+20 Kg S + 1Kg Bha^{-1}	164.0	156.0	14.8	5.0	2.14	6.10	40.4	19.4
T_7 RDF+20 Kg S + 2Kg B ha^{-1}	165.7	158.4	14.9	5.1	2.28	6.50	40.7	19.08
T_8 RDF+40 Kg S + 1Kg B ha^{-1}	168.5	160.5	15.0	5.1	2.30	6.66	41.1	20.1
T_9 RDF+40 Kg S + 2Kg B ha^{-1}	171.0	163.6	15.1	5.2	2.38	6.82	41.6	20.2
CD(P=0.05)	4.05	3.82	0.80	0.18	0.25	0.33	1.1	0.72

kg B ha^{-1} which was statistically at par with 40 kg S + 1 kg B ha^{-1}. The minimum value of test weight (4.7g) was recorded with recommended dose of fertilizers (T_1). Similar results were obtained by Jeena *et al.*(2013).Application of sulphur and boron significantly increased mustard yield over recommended dose of N P K fertilizers. The highest seed yield (2.38 t ha^{-1}) was recorded with application of 40 kg S + 2 kg B ha^{-1} which was 28.6% greater than that under recommended dose of fertilizers (1.85 t ha^{-1}). However, seed yield was comparable with the treatment of 40 kg S + 1 kg B ha^{-1} (Table 1). Addition of both levels of S (20kg and 40 kg S ha^{-1}) with RDF significantly improved the seed yield over RDF (T_1). The increase in seed yield might be due to the role of B in viability, germination and growth of pollen tubes. The stover yield was improved significantly and the highest stover yield (6.82 t ha^{-1}) was recorded with 40 kg S + 2kg B ha^{-1}. Combined application of sulphur and boron could supply more nutrients to plants for better growth and thereby crop Yields (Jaiswal *et al.* 2015, Singh *et al.* 2017).

Quality

Seed protein and oil contents are important parameters which govern the quality of mustard. The oil content of mustard seeds was significantly increased with sulphur and boron application. The oil content of seed was highest (41.6 %) under 40 kg S + 2 kg B ha^{-1} (Table 1). The oil content was however, lower with recommended dose of fertilizers. These results are in agreement with those reported by Jaiswal *et al.* (2015) and Singh etal. (2017). The protein content (20.2%) of mustard seed was significantly higher in plots receiving 40 kg S + 2kg B ha^{-1}. Application of 40 kg S + 1 kg B ha^{-1} were at par with 40 kg S + 2 kg B ha^{-1} in respect of protein content in mustard seeds. The lowest protein content in mustard seed was recorded under recommended dose of N P K fertilizers (T_1). The beneficial role of combined application of sulphur and boron in increasing seed protein concentration was also reported by Kushwaha *et al.* (2019) and Ram *et al.* (2014).

Table2: Effect of sulphur and boron levels on uptake of N, P and S(Kg ha^{-1}) and B (ha^{-1}) by mustard (mean of two years)

Treatment	Nitrogen		Phosphorus		Sulphur		Boron	
	Seed	Stover	Seed	Stover	Seed	Stover	Seed	Stover
T_1 RDF	55.1	36.8	12.3	14.4	12.8	12.2	59.6	103.5
T_2 RDF+20 Kg S ha^{-1}	60.0	40.6	13.4	16.8	14.6	14.5	62.0	116.0
T_3 RDF+40 Kg S ha^{-1}	68.0	45.8	15.3	18.7	17.1	16.7	67.6	130.4
T_4 RDF+1 Kg B ha^{-1}	60.4	41.3	13.5	17.0	13.9	13.6	69.8	133.2
T_5 RDF+2 Kg B ha^{-1}	64.2	45.4	14.4	17.9	14.9	14.9	77.4	149.0
T_6 RDF+20 Kg S + 1KgB ha^{-1}	66.3	46.3	15.0	18.9	15.8	15.8	74.9	146.4
T_7 RDF+20 Kg S + 2Kg B ha^{-1}	72.2	50.0	16.4	20.8	17.1	17.2	79.0	156.6
T_8 RDF+40 Kg S + 1Kg B ha^{-1}	72.8	51.9	16.7	22.0	17.7	17.3	82.2	166.5
T_9 RDF+40 Kg S + 2Kg B ha^{-1}	73.1	54.5	17.6	23.0	19.0	19.4	84.7	173.9
CD(P=0.05)	6.60	5.75	1.97	2.10	2.02	1.90	14.5	18.8

Nutrient uptake

Different nutritional treatments showed significantly beneficial effect on the utilisation of nutrients by mustard crop (Table 2). Application of S and B increased the nitrogen uptake by seed and stover over recommended dose of fertilizers. The uptake of N was highest under 40 kg S + 2 kg B ha^{-1} over RDF by mustard seed and stover (73.1 and 54.5 kg ha^{-1}, respectively). This increase may be attributed to increased N concentration and seed and stover yield. Similar results were also reported by Singh *et al.* (2017). The Phosphorus uptake by seed ranged from 12.3 kg ha^{-1} with RDF to 17.6 kg ha^{-1} with 40 kg S + 2 kg B ha^{-1}. On pooled basis, the uptake of P in seed and stover increased with 40 kg S +2 kg B ha^{-1} to the tune of 43.0 and 59.7% respectively over RDF. The beneficial role of S and B might have accrued from chlorophyll synthesis and stimulatory effect on most of physiological and metabolic processes. This might have helped the plants in increased absorption of nutrients from soil. The results are in accordance with the findings of Singh *et al.* (2013), Basumatary *et al.* (2019) and Ram *et al.* (2014). The combined

application of sulphur and boron was found to be significant for sulphur uptake in pooled analysis. The maximum S uptake by seed (19.0 kg ha^{-1}) and stover (19.4 kg ha^{-1})was recorded under combined application of 40 kg S + 2 kg B ha^{-1} which was significantly superior to rest of the treatments except 40 kg S + 1 kg B ha^{-1}. Minimum sulphur uptake was recorded when neither sulphur nor boron was applied. Increase in S content and yield of mustard resulted in significant increase in S uptake by mustard. Similar results have been observed by Singh *et al.* (2017) and Jeena *et al.* (2013). The uptake of B by mustard seed and stover ranged from 59.6 to 84.7 g ha^{-1} and 103.5 to 166.5g ha^{-1}, respectively. Thus, maximum uptake of B by the crop was recorded under 40 kg S + 2 kg B ha^{-1} treatment. The increase in B uptake may be due to increase in B content and yield. The increase in these parameters due to S and B application lead to an increased B uptake are in conformity with Singh *etal.* (2017).

Available S and B in soil

Available S and B content in post harvest soil significantly increased with S and B application, which varied from 14.0 to 23.0 kg ha^{-1} and 0.20 to 0.35 $mgkg^{-1}$, respectively (Table 3). The maximum values of available S (23.0 kg ha^{-1}) and boron(0.35 $mgkg^{-1}$)content in post harvest soil was recorded with 40 kg S + 2 kg B ha^{-1} treatment, while the minimum of 14.0 kg ha^{-1} and 0.20 $mgkg^{-1}$,respectively being in RDF. This increase in content of S and B in post harvest soil may be attributed to increased availability in soil as a result of their application. Similar results were reported by Jaiswal *et al.* (2015) and Singh *et al.* (2017).

Table3: Effect of sulphur and boron levels on their status in post harvest soils

Treatment	Available S (Kg. ha^{-1})	Available B (Mg $Kg.^{-1}$)
T_1 RDF	14.0	0.20
T_2 RDF+20 Kg S ha^{-1}	17.0	0.21
T_3 RDF+40 Kg S ha^{-1}	22.0	0.22
T_4 RDF+1 Kg B ha^{-1}	11.0	0.25
T_5 RDF+2 Kg B ha^{-1}	11.5	0.30
T_6 RDF+20 Kg S + 1Kg Bha^{-1}	17.5	0.26
T_7 RDF+20 Kg S + 2Kg B ha^{-1}	19.5	0.31
T_8 RDF+40 Kg S + 1Kg B ha^{-1}	22.5	0.32
T_9 RDF+40 Kg S + 2Kg B ha^{-1}	23.0	0.35
CD(P=0.05)	2.5	0.11

The study reveals that the combined application of 40 kg S +2 kg B ha^{-1} along with recommended dose of fertilizers is beneficial in increasing yield attributes of mustard crop. Similarly crop yield, quality and uptake of nutrients were also higher with the combined use of 40 kg S + 2 kg S ha^{-1} along with recommended dose of fertilizers. Thus, S could be used along with B for achieving higher crop productivity and quality of mustard crop grown on the soils of Agra region, Uttar Pradesh.

REFERENCES

Basumatary, A., Goswami, K., Ozha, Hazarika, S. and Tinsena, G. (2019) Integrated sulphur management in rapeseed (*Brasssica compestris*) black gram (*Vigna mungo*) sequence in Insaptisol of Assam, *Annals of Plant and Soil Research* **21**(1): 7-13.

Chesnin, L. and Yien, C. H. (1951) Turbidimetric determination of available sulphate. *Proceedings of the Soil Science Society of America* **15**:149-151.

Jackson, M. L. (1973) *Soil Chemical Analysis*, Prentice Hall of India Private Limited, New Delhi.

Jaiswal, A. D, Singh, S. K., Singh, Y.K., Singh, S. S. and Yadav, S. N., (2015) Effect of sulphur and boron on yield and quality of mustard *(Brassica Juncea L.)* grown on

Vindhyan red soil.*Journal of the Indian Society of soil science* **63**:362-364.

Jeena, M., Suman, J. and Indra, M. (2013) Effect of sulphur and boron on the performance of sesame (*Sesamum indicum L*) in Onattakara sandy soils of Kerala, India. *Indian Journal of Agricultural Research* **47**:214-219.

John, M. K., Chaul, H. F. and Neufied, J. H. (1975) Application of improved azomethine – H method to the determination of boron in soil and Plants. *Analytical Letters* **8**:559-568.

Kushwaha, S., Shrivastava, A. and Namdeo, K. N. (2019) Effect of sulphur on utilization of nutrients in linseed (*Linum usitatissimum L*) genotypes. *Annals of Plant and Soil Research* **21**(4):364-366.

Panse, V. G. and Sukhatme, P. V. (1985) *Statistical Methods for Agricultural workers*. ICAR, New Delhi .

Ram, H. Singh,G. and Agrawal, N. (2014) Grain yield , nutrient uptake, quality and economics of soyabean (*Glycine max*) under different sulphur and boron levels in Punjab. *Indian Journal of Agronomy* **59** (1):101-105.

Singh, B. Sharma, Y. Babel, A. L. and Kamoriya, P. R. (2013) Effect of sulphur and zinc on yield of and uptake by mustard. *Journal of the Indian Society of Soil Science* **61** (1):59-62.

Singh, R., Singh, Y. and Singh, S. (2017) Yield quality and nutrient uptake of Indian mustard under sulphur and boron nutrition. *Annals of Plant and Soil Research* **19** (2):227-231.