Original Research Article

Effect of Boron and sulphur on growth, yield of mustard (*Brassica juncea* L.)

ABSTRACT

A field experiment was conducted during the rabi season of 2021-22 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj to study the response of Indian mustard [*Brassica juncea* (L)] to different levels of sulphur and boron. The experiment was comprised of 9 treatments with including all the combination of three sulphur levels (0, 10 and 20 kg/ha) and three levels of boron (0, 2 and 4 kg/ha). Results revealed that the highest plant height, plant dry weight (g/plant), crop growth rate (g/m2/day), relative growth rate (g/g/day), Number of siliqua per plant, Number of seed per siliqua, test weight (gm), Seed yield (q/ha), Stover yield (q/ha) were recorded with combination Boron (2 kg/ha) + Sulphur (20 kg/h) and application of (control) recorded maximum harvest index (%). Maximum gross return, net return and B:C ratio were also recorded with application of Boron 2 kg/ha + Sulphur 20 kg/ha.

Key Word : Mustard, Boron, Sulphur, Yield, Growth

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INTRODUCTION

Mustard is the second most important oil seed crop, contributing nearly 25-30% of the total oil seed production in the country. Optimum nutrition is required for getting maximum seed yield and good quality of the grain. Several abcotic and biotic factors have been found to effect mustard yields apart from major plant nutrients (N, P and K) sulphur and boron play an important role in the production phenology of oil seed crops and these crops respond well to applied sulphur and boron (Karthikeyan and Shukla 2008). For oil seeds, sulphur and boron are most vital nutrients for the growth and development. Sulphur is considered to be the fourth important essential nutrient after nitrogen, phosphorus and potassium for the plant growth. Sulphur performs many physiological functions like synthesis of cystein, cystine, methionine chloroephyll and oil content of oil seed crops. It is also responsible for synthesis of certain vitamins (B, biotin and thiamine), metabolism of carbohydrates, proteins and

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oil formation of flavour compounds in crucifers. Brassica has the highest sulphur requirement owing to the presence of sulphur rich glucosinolates. Boron is an essential micronutrient for higher plants. The role of B within the plant includes cell-wall synthesis, sugar transport, cell-division and different actions in membrane functioning, root elongation, regulation of plant hormone levels and generative growth of plants. The quality of seeds deteriorated in decreased content of boron, starch, protein and oil along with stimulated concentrations of sugars and phenols. Application of B is essential for crops grown in soils with available B belon critical limit of 0.5 mg kg-1 (Ramana *et al*. 2016). However; studies investigating the impact of sulphur and boron application on yield of mustard remain scarce. Therefore, the present investigation was planned to study the effect of sulphur and boron on yield, nutrient uptake and quality of mustard.

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MATERIALS AND METHODS

A field experiment entitled, "Effect of Boron and sulphur on growth and yield of Mustard" (*Brassica juncea* L.), was conducted during *rabi* season of 2021-22. The experiment was laid out in the Crop Research Farm, Department of Agronomy, Prayagraj, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj. The Crop Research Farm is situated at 25.77^0 North latitude, 81.50^0 East longitude and 98 m altitude from the sea level. The Crop Research Farm is situated at 25.77^0 North latitude, 81.50^0 East longitude and 98 m altitude from the sea level. The soil was sandy loam, slightly above neutral in reaction (pH 7.4), low in organic carbon (0.32 %), available Potassium (78 kg/ha) and low in available phosphorus (34.5 kg/ha). Treatments consisting of four level each of sulphur levels (0, 10 and 20 kg/ha) and boron (0, 2 and 4 kg/ha) were replicated thrice in randomized block design.

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Comment [M9]: Only three treatments including level 0

The experiment comprising of nine treatment combinations viz., 1.Control, 2.Sulphur 10 kg/ha, 3.Sulphur 20 kg/ha, 4.Boron 2 kg/ha, 5.Boron 2kg/ha + Sulphur 10 kg/ha, 6.Boron 2 kg/ha + Sulphur 20 kg/ha, 7.Boron 4 kg/ha, *8*.Boron 4kg/ha + Sulphur 10 kg/ha and 9.Boron 4 kg/ha + Sulphur 20 kg/ha. For recording observations on growth and yield attributes viz., plant height (cm), plant dry weight (g/plant), crop growth rate (g/m2/day), relative growth rate (g/g/day), number of siliqua, number of seed per siliqua, test weight (gm), seed yield (t/ha), stover yield (t/ha) and harvest index (%).

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RESULTS AND DISCUSSION

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The observations for growth parameters are being presented in the table 1. A perusal of this table reveals that there was a steady increase in the Plant height (cm) at 120 DAS, Plant dry weight (g/plant) at 120 DAS, Crop growth rate (g/m2/day) at 100-120 DAS and Relative growth rate (g/g/day) at 100-120 DAS showing some significant impact on the effect of boron and sulphur on growth of mustard. While as Relative growth rate (g/g/day) at 100-120 DAS the effect of the treatments were non-significant. At 120 DAS, there was significant difference between the treatments and maximum plant height (163.01cm) was observed the applications of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest plant height value (127.10 cm) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). However, Boron (0 kg/ha) + Sulphur (10 kg/ha) are found statistically at par to Boron (2 kg/ha) + Sulphur (20 kg/ha). At 120 DAS, there was significant difference between the treatments and maximum plant dry weight (g/plant) (67.85) was observed the applications of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest plant dry weight (g/plant) value (44.70) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). At 100-120 DAS, there was significant difference between the treatments and maximum crop growth rate (CGR) (g/m2/day) (9.63) was observed the applications of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest crop growth rate (CGR) (g/m2/day) value (4.69) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). However, Boron (2kg / ha) + Sulphur (10 kg/ha) are found statistically at par to Boron (2 kg/ha) + Sulphur (20 kg/ha). At 100-120 DAS, there was non-significant difference between the treatments and maximum relative growth rate (RGR) (g/g/day) (0.0107) was observed the applications of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest relative growth rate (RGR) (g/g/day) (0.0061) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). Result is in agreement with the findings of Verma *et al*. (2012). The increase in plant height because sulphur increased activity of merismetic tissue resulting in increase in plant height and cell elongation and boron also helps in cell elongation, photosynthesis and translocation of photosynthates. The availability of nutrient in adequate amount resulted in formation of photosynthates, which promote the metabolic activities, increased cell division, ultimately increase the number of primary and secondary branches. A similar finding was found by Yadav *et al.* (2016). In case of dry matter accumulation boron and sulphur helps in formation of deep green colour due to synthesis of chlorophyll which in turn provide the larger area for photosynthesis. This results in greater amount of dry matter accumulation in comparison to sulphur deficient plant (Kumar and Yadav, 2007).

Observations regarding the response of Boron and sulphur on yield and yield attributes of Mustard (*Brassica spp.*) are given in table 2. The observation showed that at yield and yield attributes there was significant difference between treatments. The results revealed that there was significant difference between the treatments and maximum Number of siliqua per plant (335.89) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest value Number of siliqua per plant (257.14) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). Similar findings were also recorded by Kumar *et al*. (2000) and Akter *et al*. (2007). Yeasmin *et al*. (2013) had also reported positive effect of various levels of sulphur application on yield component of mustard. Optimum dose of boron significantly increased the number of seeds/siliqua. Nutrients requirement increases during initial stages to develop stages of grain filling in mustard. Thus application of boron and sulphur helps in photosynthesis and their translocation to sink. Kumar *et al.* (2000) and Jat *et al.* (2008) reported similar findings. The results revealed that there was significant difference between the treatments and maximum Number of seed per siliqua (14.20) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest value Number of seed per siliqua (10.14) was observed in treatment Boron (0 kg / ha) + Sulphur (0 kg/ha). However, Boron (4 kg/ha) + Sulphur (20 kg/ha) are found statistically at par to Boron (2 kg/ ha)+ Sulphur (20 kg/ha). The results revealed that there was significant difference between the treatments and maximum test weight (gm) (6.03) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest value test weight (gm) (4.24) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). The results revealed that there was significant difference between the treatments and maximum Seed yield (q/ha) (26.16) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest value Seed yield (q/ha) (19.52) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). However, Boron (2 kg/ha) + Sulphur (0 kg/ha) are found statistically at par to Boron (2 kg/ha) + Sulphur (20 kg/ha). The results revealed that there was significant difference between the treatments and maximum Stover yield (q/ha) (68.45) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas the lowest value Stover yield (q/ha) (43.38) was observed in treatment Boron (0 kg/ha) + Sulphur (0 kg/ha). The results revealed that there was significant difference between the treatments and maximum harvest index (%) (68.45) was observed by the application of Boron (0 kg/ha) + Sulphur (0 kg/ha), whereas the lowest value Stover yield (q/ha) (25.92) was observed in treatment Boron (2 kg/ha) + Sulphur (10 kg/ha). However, Boron (0 kg/ha) + Sulphur (10 kg/ha) are found statistically at par to Boron (2 kg/ha) + Sulphur (20 kg/ha). The enhancement of seed yield in mustard due to the application of sulphur had also been reported by Suresh *et al.* (2002) and Raut et al. (2003). This improvement might be due to the translocation of photosynthates leading to improvement in higher seed yield and stover yield. Chatterjee *et al.* (1985) reported that application of borax increased seed yield of mustard over control. This may be due to the role of boron in fertility improvement and translocation of photosynthates to sink. These results are in close conformity to those of Chander *et al.* (2010).

Table 1 Effect of Boron and sulphur on plant height (cm) of mustard

Treatment No.	Treatment details	growth parameters			
		Plant height (cm) at 120 DAS	**Plant dry weight (g/plant) at 120 DAS**	**Crop growth rate (CGR) (g/m2/day) at 100-120 DAS**	**Relative growth rate (RGR) (g/g/day) at 100-120 DAS**
1.	Control	127.10	44.70	4.69	0.0061
2.	Sulphur 10 kg/ha	154.04	52.12	5.88	0.0083
3.	Sulphur 20 kg/ha	147.07	54.30	5.20	0.0069
4.	Boron 2 kg/ha	160.14	61.19	5.21	0.0076
5.	Boron 2kg/ha + Sulphur 10 kg/ha	160.74	61.80	7.38	0.0088
6.	Boron 2 kg/ha + Sulphur 20 kg/ha	163.01	67.85	9.63	0.0107
7.	Boron 4 kg/ha	159.18	60.14	6.87	0.0084
8.	Boron 4kg/ha + Sulphur 10 kg/ha	150.80	58.85	6.33	0.0078
9.	Boron 4 kg/ha + Sulphur 20 kg/ha	161.64	63.31	8.01	0.0094
	F Test	**S**	**S**	**S**	**NS**
	CD (p=0.5)	**8.592**	**3.679**	**1.838**	**-**
	SEd (+)	**4.053**	**1.735**	**0.867**	**0.002**

Comment [M13]: SDs of triplicate measurements for each treatment are not reported.

Table 2 Effect of Boron and sulphur on yield and yield attributes of mustard

Treatment No.	Treatment details	Yield and yield attributes					
		Number of siliqua per plant	Number of seed per siliqua	Test weight (gm)	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)
1.	Control	257.14	10.14	4.24	19.52	43.38	31.07
2.	Sulphur 10 kg/ha	323.12	11.09	5.41	21.94	51.77	29.77
3.	Sulphur 20 kg/ha	319.87	12.24	5.24	23.78	61.72	27.82
4.	Boron 2 kg/ha	323.38	11.32	5.02	24.09	62.27	27.89
5.	Boron 2kg/ha + Sulphur 10 kg/ha	316.71	11.82	5.25	22.49	64.31	25.92
6.	Boron 2 kg/ha + Sulphur 20 kg/ha	335.89	14.20	6.03	26.16	68.45	27.66
7.	Boron 4 kg/ha	322.69	11.77	5.38	23.78	62.38	27.59
8.	Boron 4kg/ha + Sulphur 10 kg/ha	319.20	12.43	5.30	22.92	62.50	26.83
9.	Boron 4 kg/ha + Sulphur 20 kg/ha	334.41	13.17	5.79	25.43	64.45	28.29
	F Test	**S**	**S**	**S**	**S**	**S**	**S**
	CD (p=0.5)	**8.415**	**0.929**	**0.540**	**1.386**	**3.009**	**1.873**
	SEd (+)	**3.969**	**0.438**	**0.255**	**0.654**	**1.419**	**0.883**

Comment [M14]: t/ha in secc Materials and Methods

CONCLUSION

It is concluded that Boron 2 kg/ha + Sulphur 20 kg/ha was found to be the best treatment for obtaining higher gross return (112095.00 INR./ha), net return (80795.00 INR./ha) and B:C ratio (1:2.58) in compared to other treatments. Since the results in based on one year experiment, further trials may be done to confirm the findings.

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