Original Research Article

Determining the influence of Boron and Sulphur on growth, yield and nutrient uptake of mustard (*Brassica juncea* L.)

ABSTRACT

A field experiment was carried out 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 : Boron, Growth, Mustard, Sulphur, Yield

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 nitrogen (N), phosphorus (P), potassium (K), sulphur (S) and boron (B) 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 (N), phosphorus (P) and potassium (K) for the plant growth. Sulphur performs many physiological functions like synthesis of cystein, cystine, methionine chloroephyll and oil content of oil seed crops" (Aachary and Thiyam 2012). In crucifers, it is also essential for the synthesis of some vitamins (B, biotin, and thiamine), carbohydrate metabolism, protein metabolism, and oil creation of flavor compounds. Due to the presence of sulphur-rich glucosinolates, Brassica has the greatest sulphur requirement. Boron is an essential micronutrient for higher plants. The role of Boron 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.

MATERIALS AND METHODS

A field experiment 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. Treatments consisting of three level each of sulphur levels [0 (Control), 10 and 20 kg/ha] and boron [0 (control), 2 and 4 kg/ha] were replicated thrice in randomized block design.

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/m^2/day), relative growth rate (g/g/day), number of siliqua, number of seed per siliqua, test weight (kg), seed yield (t/ha), stover yield (ton/ha) and harvest index (%).

RESULTS AND DISCUSSION

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 days after sowing, 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/m^2/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). The results are consistent with the findings of Verma et al(2012). Sulphur boosted the activity of merismetic tissue, resulting in an increase in plant height and cell elongation, while boron also aids cell elongation, photosynthesis, and photosynthate translocation. The creation of photosynthates, which enhance metabolic activities, accelerated cell division, and finally increased the number of primary and secondary branches, was aided by the availability of sufficient nutrients. Yadav et al. discovered a similar result (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 findings revealed that there was a considerable difference between treatments in terms of yield and yield characteristics. 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". Similar findings were reported by Kumar et al. (2000) and Jat et al. (2008). 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 showed 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 findings closely resemble those of Chander et al (2010).

Table 1 The Effect of Boron and sulphur on plant height and weight 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/m^2/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**	**-**

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 (t/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**

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. Because the conclusions are based on a one-year experiment, more tests may be conducted to corroborate the findings.

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