

Original Research Article

Effect of Boron and sulphur-Sulphur on gGrowth, and yield-Yield of mustard 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-Sulphur and boron-Boron. The experiment ~~was comprised of 9 treatments with~~ comprised nine treatments, including ~~all~~ the combination of three sulphur levels (0, 10 and 20 kg/ha) and three levels of boron-Boron (0, 2 and 4 kg/ha). ~~The R~~ e results revealed that the highest plant height, plant dry weight (g/plant), crop growth rate ($\text{g/m}^2/\text{day}$), relative growth rate (g/g/day), Number of siliqua per plant, Number of seed per siliqua, test weight (gm), Seed yield (q/ha), and Stover yield (q/ha) were recorded with combination Boron (2 kg/ha) + Sulphur (20 kg/h) and application of (control) The 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.

Formatted: Superscript

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

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~~ to get maximum seed yield and good grain quality. Several ~~abiotic-abiotic~~ and biotic factors have been found to ~~effect~~ affect mustard yields. ~~A~~ apart from major plant nutrients (N, P and K), sulphur and boron-Boron play an important role in the production phenology of oil-seed crops, and these crops respond well to applied sulphur-Sulphur and boron (Karthikeyan and Shukla 2008). ~~For oil seeds, sulphur and boron are most vital nutrients for the growth and development~~ Sulphur and Boron are the most vital nutrients for the growth and development of oilseeds. Sulphur is considered ~~to be~~ the fourth important essential nutrient after nitrogen, phosphorus and potassium for ~~the~~ plant growth. ~~Sulphur-It~~

performs many physiological functions like ~~synthesizing~~ synthesis of cysteine, cystine, methionine chlorophyll and oil content of oil-seed crops. It is also responsible for ~~synthesizing~~ ~~ofing~~ ~~eeertain~~ ~~specific~~ 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~~ 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~~ Boron, starch, protein and oil ~~along with and~~ stimulated concentrations of sugars and phenols. Application of B is essential for crops grown in soils with ~~an~~ available B below critical limit of 0.5 mg kg⁻¹ (Ramana *et al.* 2016). However, ~~studies~~ studies investigating the impact of ~~sulphur~~ Sulphur and boron application on ~~the~~ yield of mustard remain scarce. Therefore, the present investigation was planned to study the effect of ~~sulphur~~ Sulphur and ~~boron~~ Boron on yield, nutrient uptake and quality of mustard.

MATERIALS AND METHODS

A field experiment entitled, “Effect of Boron and sulphur on growth and yield of Mustard” (*Brassica juncea* L.), was conducted during ~~the~~ 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' North latitude, 81°50' East longitude and 98 m altitude from the sea level. The Crop Research Farm is situated at 25°77' North latitude, 81°50' 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 levels each of sulphur levels (0, 10 and 20 kg/ha) and ~~boron~~ Boron (0, 2 and 4 kg/ha) were replicated thrice in ~~a~~ 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/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 (%).

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 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-Boron and sulphur-Sulphur on the growth of mustard. While as Relative growth rate (g/g/day) at 100-120 DAS, the effect of the treatments were-was non-significant. At 120 DAS, there was a significant difference between the treatments and maximum plant height (163.01cm) was observed in the applications of Boron (2 kg/ha) + Sulphur (20 kg/ha), whereas, In contrast, 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 a significant difference between the treatments and maximum plant dry weight (g/plant) (67.85) was observed in 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-The result is in agreement with the findings of Verma *et al.* (2012). The increase in plant height because sulphur-Sulphur increased-increases activity of meristematic tissue resulting in increase in plant height and cell elongation and boron also helps in cell

~~elongation, photosynthesis~~ meristematic tissue activity, increasing plant height and cell elongation. Boron also helps in cell elongation, photosynthesis, and translocation of photosynthates. The availability of nutrients in an adequate amount resulted in photosynthates' formation, which promotes the metabolic activities, increases cell division, and ultimately increases formation of photosynthates, which promote the metabolic activities, increased cell division, ultimately increase the number. Number of primary and secondary branches. A similar finding was found by Yadav *et al.* (2016). In the case of dry matter accumulation ~~boron and sulphur helps in formation of deep green colour due to synthesis of chlorophyll which in turn provide~~, Boron and Sulphur helps form deep green colour due to the synthesis of chlorophyll, which provides the a larger area for photosynthesis. This results in greater amount of dry matter accumulation in comparison to a greater amount of dry matter accumulation than a sulphur-Sulphur deficient plant (Kumar and Yadav, 2007).

Observations regarding the response of Boron and sulphur-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 treatment~~ there was significant difference between treatments at yield and yield attributes. The results revealed that there was a significant difference between the treatments. ~~The maximum Number of siliqua per plant (335.89) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha). In contrast, 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 a positive effect of various levels of sulphur application on the yield component of mustard. ~~Optimum~~ The optimum dose of boron-Boron significantly increased the number of seeds/siliqua. ~~The nutrients~~ requirement increases during the initial stages to develop ~~stages of grain filling~~ grain filling stages in mustard. Thus the application of boron-Boron and sulphur-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 a significant difference between the treatments. ~~The maximum number of seed per siliqua (14.20) was observed by the application of Boron (2 kg/ha) + Sulphur (20 kg/ha). In contrast,~~

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 a 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, In contrast, 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 a 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, In contrast, 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 a 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 a 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-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' translocation, leading to improvement in higher seed yield and stover yield. Chatterjee *et al.* (1985) reported that the application of borax increased the seed yield of mustard over control. This may be due to the role of boron-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-Sulphur on plant height (cm) of mustard

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

CONCLUSION

~~It is concluded~~We can conclude 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~~are based on a one-year experiment, further— trials may be done to confirm the findings.

REFERENCES

- Akter S, Hossain K, Rahaman S, Ullah MM. 2007. Effect of fertilizer on yield and yield component of mustard. *International Journal of Sustainable Agricultural Technology*. 3(5):93-96.
- Chander G, Verma TS, Sharma S. 2010. Nutrient content of cauliflower (*Brassica olerace* L. var. botrytis) as influenced by boron and farmyard manure in north west himalayanalfisols. *Journal of the Indian Society of Soil Science*. 58(2):248-251.
- Chatterjee BN, Ghosh MK, Chakraborty PK. 1985. Response of mustard to ~~sulphur~~Sulphur and micronutrients. *Indian Journal of Agronomy*. 30(1):75-78.
- Jat G, Sharma KK, Kumawat BL, Bairwa FC. 2008. Effect of FYM and mineral nutrition on yield attributes, yield and net return of mustard. *Annals of plant and Soil Research*. 10(1):92-95.
- Karthikeyan, K. and Shukla, L.M. 2008. Effect of boron-sulphur interaction on their uptake and quality parameters of mustard (*Brassica juncea* L.) and sunflower (*Helianthus annuus* L). *Jouranal of the Indian Society of Soil Science* 56(2) 225- 230.
- Kumar H, Yadav DS. 2007. Effect of phosphorus and ~~sulphur~~Sulphur on growth, yield and quality of mustard (*Brassica juncea*) cultivars. *Indian Journal of Agronomy*. 2007; 52(2):154- 157.
- Kumar R, Singh D, Singh H. 2000. Growth and yield of Brassica species as influenced by sulphur application and sowing dates. *Indian Journal of Agronomy*.; 47(3):417-421.
- Ramana, P.V., Gladis, P and Nagula, S. 2016. Effect of magnesium and boron nutrition on yield and quality of black pepper in laterite soils. *Annals of Plant and Soil Research* 18 (4): 401-404
- Raut RF, Hamid A, Ganvir MM. 2003. Effect of irrigation and ~~sulphur~~Sulphur in growth and yield of mustard. *Annals of Plant Physiology*. 17(1):12-16.

Suresh K, Tripathi PN, Room S, Kumar S, Singh R. 2002. Response of Indian mustard to sources and levels of ~~sulphur~~-Sulphur in partially reclaimed salt affected soil. *Indian Journal of Agricultural Science*. 72(1):22-25.

Verma CK, Prasad K, Yadav DD. 2012. Studies on response of sulphur, zinc and boron levels on yield, economics and nutrients uptake of mustard (*Brassica juncea* L.). *Crop Research*. 44(1):75-78.

Yadav SN, Singh SK, Kumar O. 2016. Effect of ~~boron~~-Boron on yield attributes, seed yield and oil content of mustard (*Brassica juncea* L.) on an inceptisol. *Journal of the Indian Society of Soil Science*. 64(3):291-296.

Yeasmin F, Hasan MM, Hossain MB, Alam MS. 2013. Effect of ~~sulphur~~-Sulphur and ~~boron~~-Boron on yield and yield components of rapeseed. *Bangladesh Journal of Progressive Science and Technology*. 11(1):21-24.

UNDER PEER REVIEW