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Effect of Boron Levels and Row Spacing on Growth and Yield of Mustard (*Brassica juncea* L.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted during *Rabi* 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) to evaluate the effect of boron levels and row spacing on growth and yield of mustard (*Brassica juncea* L.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2). The experiment was laid out in a randomized block design with nine treatments with three replications. The treatments comprising of different levels of boron and row spacing whose effect was observed in mustard. The results obtained that the application of boron @3 kg/ha plus row spacing of 30cm recorded significantly maximum plant height (192.53 cm), plant dry weight (36.95 g/plant), number of siliquea/plant (314.47), test weight (5.14g), number of seeds/siliquea (15.33), stover yield (4.61 t/ha), seed yield (2.48 t/ha). Therefore, treatment with application of boron @3 kg/ha long with row spacing of 30cm was more productive and can be recommended to farmers after further trails.

Keywords: Boron; row spacing; yield; mustard.

1. INTRODUCTION

Oilseeds are the major contributors in the agricultural and industrial sector of India and hold its position only next to cereals in terms of area, production and value. Mustard (*B. juncea L.*) belongs to the family of "Cruciferae" and popularly used in Indian cooking. It has also

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been reported that mustard crop had cultivated in Channhu-daro of Harrapan ancient civilization during 2300-1750 BC [1]. There is ambiguity in the history as the origin of B. juncea is concerned. It had been believed that center of origin for B. juncea is Middle-East, where putative parents i.e. B. nigra and B. rapa would have crossed with each other. Later on, it had been disseminated to other parts of the world such as Europe, Asia, and Africa etc. India is the third largest mustard producer in the world after China and Canada with 12% of world total production [2]. " Mustard is the second most important and most prominent winter oilseed crop of India. It is grown mainly in the northern plains of India with some cultivated area in the eastern geography as well. Time of sowing stands as a constant factor in determining the yield and oilseed content in the mustard seeds, unless the drastic reduction in the yield remains imminent" [3]. "Most critical stages are observed as emergence, flowering, siliquae formation and grain developmental stages" [4]. Mustard seed production is estimated at 109.5 lakh tonnes in 2021-22. The area under coverage has been pegged at 87.44 lakh hectares while the average yield is seen at 1,270 kg per hectare. Mustard seeds are grown only in rabi season and the sowing starts from October, while harvesting begins in March. Mustard is an important cash crop for farmers in Rajasthan, Haryana, Madhya Pradesh and Uttar Pradesh, among others. In Uttar Pradesh, the production is projected to increase from 13.5 lakh tonnes to 15 lakh tonnes.

Boron is one of the essential micronutrients required for normal growth of most of the plants. It helps in the normal growth of plant and in adsorption of nitrogen (N) in soil and also makes up the calcium (Ca) deficiency to some extent. Boron plays an important role in cell differentiation, regulating membrane permeability, tissue differentiation, carbohydrates and protein metabolism. It also helps in translocation of photosynthesis and growth regulators from source to sink and growth of pollen grains thereby increase in seed yield of crops. Boron is involved in plant functions such as cell wall development, cell wall strengths, cell division, fruit and seed production, and sugar transport are related to boron fertilization. Boron (B) fertilization is required for increasing crop yield and nutritional quality. There have been numerous reports on mustard's positive response to B fertilization [5]. Brassicas have a greater boron need, and a severe deficit can lead to floral abortion and a reduction in seed yield [6]. Apart from essential plant nutrients, boron is vital in the phenology of mustard production, and this crop responds to boron application [2].

"Row spacing is one of the very important practices for mustard production. Improved varieties of mustard are capable of higher yields when grown under optimum row spacing and fertility level. The major row spacing of mustard decrease seed yield through synchronization of siliquae filling period with high temperature, the decrease in assimilates production, drought stress occurrence, shortened silique filling period and acceleration of plant maturity" [7]. **"**Plant density is an important cultural practice that determines number of pods, number of siliquae and other growth attributes of Mustard. Spacing is dependent on variety, its growth habit and agro-climatic environment" [8]. Light attenuation in row crops may be influenced by canopy architecture, which has to be defined in terms of the size, shape orientation of shoot components and row spacing [9]. The purpose of the study is to observe the effect of boron levels and row spacing on growth and yield of mustard. This can increase the production and productivity of the crop.

2. MATERIALS AND METHODS

The experiment was conducted during *Rabi* season of 2021. The experiment was conducted in a randomized block design consisting of nine treatments combinations with three replications. The soil of the experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.2), low in organic carbon (0.22%), available N (171.48 kg/ha), available P (12.3 kg/ha) and available K (235.7 kg/ha). The treatments viz T1- Boron 1 kg/ha + Row spacing 20cm, T2- Boron 1 kg/ha + Row spacing 30cm, T3- Boron 1 kg/ha + Row spacing 40cm, T4- Boron 2 kg/ha + Row spacing 20cm, T5- Boron 2 kg/ha + Row spacing 30cm, T6- Boron 2 kg/ha + Row spacing 40cm, T7- Boron 3 kg/ha + Row spacing 20cm, T8- Boron 3 kg/ha + Row spacing 30cm, T9- Boron 3 kg/ha + Row spacing 40cm. The observations were recorded on different growth parameters at harvest viz. plant height (cm), plant dry weight(g), Number of siliqua per plant, number of seeds per siliqua, test weight(g), seed yield(t/ha) and stover yield(t/ha), Harvest Index(%)= Grain yield/ Biological yield×100.

Fig. 1. Sowing

Fig. 2. Measuring plant height

Fig. 3. Picture with my advisor

Fig. 4. Crop harvesting

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Crop growth parameters in mustard were measured in terms of plant height (cm) and plant dry weight. Plant height and plant dry weight were significantly influenced by the application on boron and row spacing at different stages. Plant height, and dry weight were significantly influenced due to different levels of boron and row spacing are shown in (Table1). At harvest maximum plant height (192.53 cm) were observed in treatment T_8 with application of boron 3 kg and row spacing of 30cm and treatment T_9 with application of boron 3 kg and row spacing of 40cm was statistically at par. From the (Table 1) the result was observed that increasing level of boron levels from 1 kg/ha to 3 kg/ha and different row spacing has significant effect on the plant height of mustard. Increase in plant height might be due to application of boron

Table 1. Effect of boron levels and row spacing on growth attributes of mustard

Treatments	Plant height (cm)	Plant dry weight (g)
Boron 1kg+ Row Spacing 20cm	183.07	34.34
Boron 1kg+ Row Spacing 30cm	185.01	34.71
Boron 1kg+ Row Spacing 40cm	184.18	34.55
Boron 2kg+ Row Spacing 20cm	185.97	34.79
Boron 2kg+ Row Spacing 30cm	189.07	36.27
Boron 2kg+ Row Spacing 40cm	187.74	35.88
Boron 3kg+ Row Spacing 20cm	186.80	35.28
Boron 3kg+ Row Spacing 30cm	192.53	36.95
Boron 3kg+ Row Spacing 40cm	190.41	36.47
F test	S	S
SEm(±)	0.72	0.25
CD (p=0.05)	2.16	0.75

Table 2. Effect of boron levels and row spacing on yield attributes and yield of Mustard

Treatments	No. of Siliquae per plant	No. of seedsper Siliquae	Test weight (gm)	Seed yield(t/ha)	Stover yield(t/ha)	Harvest index (%)
Boron 1kg+ RowSpacing 20cm	295.67	13.33	4.41	1.82	3.82	32.25
Boron 1kg+ RowSpacing 30cm	302.20	13.73	4.72	2.04	4.05	33.48
Boron 1kg+ RowSpacing 40cm	298.13	13.60	4.59	1.94	3.91	33.20
Boron 2kg+ RowSpacing 20cm	306.67	13.87	4.75	2.10	4.14	33.62
Boron 2kg+ RowSpacing 30cm	309.33	14.60	4.99	2.27	4.45	33.79
Boron 2kg+ RowSpacing 40cm	308.93	14.73	4.93	2.25	4.36	34.03
Boron 3kg+ RowSpacing 20cm	306.93	14.00	4.81	2.17	4.27	33.66
Boron 3kg+ RowSpacing 30cm	314.47	15.33	5.14	2.48	4.61	34.96
Boron 3kg+ RowSpacing 40cm	312.93	14.87	5.04	2.43	4.55	34.14
F test	S	S	S	S	S	S
SEm (±)	1.51	0.19	0.06	0.03	0.03	0.29
CD (5%)	4.54	0.57	0.18	0.09	0.10	0.86

which play a major role in cell elongation, photosynthesis and translocation of photosynthates. These results are also in close conformity with the results of Smita et al*.* [10] and Yadav et al. [2]. Greater spacing between plants provided more space, sunlight, nutrients, and soil moisture for improved photosynthesis, metabolic processes, and growth and development.

Significantly higher dry weight (36.95 g/plant), was observed in treatment T_8 with application of boron 3 kg and row spacing of 30cm and treatment T_9 with application of boron 3kg and row spacing of 40cm and treatment T_5 with application of boron 2 kg and row spacing of 30cm was statistically at par as compared to other treatments. From the (Table 1) the result was observed that increasing level of boron levels from 1kg/ha to 3 kg/ha and different row spacing has significant effect on the dry weight of mustard. In case of dry matter accumulation boron aids in the production of deep green color due to the synthesis of chlorophyll, which in turn provides more area for photosynthesis [10].

3.2 Yield Attributes

Yield attributes are the resultant of vegetative development of plant and determines the yield. The observations regarding yield and yield attributes *viz*., number of siliquae/plant, number of seeds/siliqua, test weight(g), seed yield, test weight, stover yield and harvest index was significantly influenced by boron levels and row spacing are shown in (Table 2). Significantly higher number of siliquae/plant (314.47), higher number of seeds/siliquea (15.33) and higher seed yield (2.48 t/ha) were observed in treatment T_8 with application of boron 3 kg and row spacing of 30cm and treatment with application of boron 3 kg and row spacing of 40cm was statistically at par. The beneficial effect of B on yield attributes may be due to its role in flower development, pollen grain formation, pollen viability, pollen tube growth for proper pollination and seed development. The findings were in line with those reported by Yadav et al*.* [2]. Mustard's major row spacing reduces seed yield by synchronising the siliquae filling phase with high temperatures, lowering assimilate production, causing drought stress, shortening the silique filling period, and accelerating plant maturity [11].

Significantly higher test weight (5.14g) observed in treatment T_8 with application of boron 3 kg and row spacing of 30cm and treatment T_9 with application of boron 3kg and row spacing of 40cm and treatment T_5 with application of boron 2 kg and row spacing of 30cm was statistically at par. The maximum TSW recorded from plants at widestspacing may be result of active photosynthetic machinery for longer period of time as plants did not face any competition for moisture or nutrients [12]. Significantly higher stover yield (4.61 t/ha) was observed in treatment T_8 with application of boron 3 kg and row spacing of 30cm and treatment with application of boron 3 kg and row spacing of 40cm was statistically at par. Boron supplementation increased main nutrient intake, resulting in increased photosynthetic activities and plant vegetative development. Finally, due to adequate metabolic activities, this rapid development resulted in a larger stover yield in mustard. From the (Table 2) the result was observed that increasing level of boron levels from 1kg/ha to 3 kg/ha and different row spacing has significant effect on all the yield attributes such as number of siliquae/plant, number of seeds/siliqua, test weight(g), seed yield, test weight, stover yield and harvest index.

4. CONCLUSION

From the above results, it is concluded that application boron 3 kg with row spacing of 30cm performed better in growth and yield parameters and is economically viable.

The conclusions drawn here based on one season data only, which requires further confirmation for recommendation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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