Original Research Article

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

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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 phosphorus and boron levels 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 consisting of nine treatments with three replications. The treatments comprising of different levels of phosphorus and boron whose effect was observed in mustard. The results obtained that the application of Phosphorus @ 60 kg/ha along with Boron @ 2.0 kg/ha was recorded significantly higher Plant height (187.59 cm), Plant dry weight (37.92 g/plant), Number of Siliquae/plant (319.80), Number of Seeds/siliquae (14.60), Test weight (5.19 g), Seed yield (2.61 t/ha) and Stover yield (4.55 t/ha). Therefore, treatment with the application of Phosphorus @ 60 kg/ha along with Boron @ 2.0 kg/ha was more productive and can be recommended to farmers after further trails.

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***Key words: -** Phosphorus, Boron, Growth, Yield*

Comment [WU8]: Name of yield contributing parameters???

INTRODUCTION

Mustard (*Brassica juncea* L.) is one of the several plant species in the genera Brassica and Sinapis in the family Brassicaceae. Mustard seed is used as a spice. The seeds can also be pressed to make mustard oil, and the edible leaves can be eaten as mustard greens. It is known as rai, raya or laha. They are generally divided into four groups: Brown mustard, Sarson, Toria and Taramira. In trade sarson, toria and taramira are known as rapeseed. India is the one the largest vegetable oil economies in the world next only to USA, China and Brazil. Brassicaceae occupies about 23% area and 14.6% production in India. Rapeseed-mustard in world production India ranks third after Canada and China. Its seed contains 37-49% oil. The oil and seeds are used as condiment in the preparation of pickles and for flavoring curies and vegetables. In India, mustard is the second important edible oil seed after groundnut. In India mustard is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Hariyana, Madhya Pradesh and Gujarat. Rajasthan ranks first in area and production of rapeseed and mustard with 2.50 million ha area and 3.71 million tonnes production [1]. In our country, among the oil seed crops, rapeseed and mustard are the most important and highly promising group of crops under different agro-climatic conditions. Among them, Indian mustard, alone accounts for about 80 percent of the 6.3 m ha area under rapeseed and mustard crops of the country [2]. Rapeseed- mustard oil is considered to be an important constituent of Indian diet and its oil is used as main cooking medium especially in northern India. Both

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the seed and oil are used as condiment in the preparation of pickles and flavoring curries and vegetables. Apart from this oil is also utilized for preparation of hair oils, medicines and soap making.

Phosphorus (P) is critical in plant metabolism which plays an important role in energy transfer, respiration and photosynthesis. It is a key structural component of nucleic acids, co-enzymes, phosphoproteins and phospholipids. For most plant species, the total phosphorus content of healthy leaf tissue is not high, usually comprising only 0.2 and 0.4 per cent of the dry matter [3]. Deficiency of phosphorus restricts growth of roots and of aerial parts of rapeseed and mustard plants and in extreme cases can prevent flowering. The crop remaining dwarf with small leaves and no inflorescence. Where phosphorus deficiency is slight, growth is restricted in the rosette stage but the crop tence to recover and the flowering stage may be little affected. Flowering may be delayed by a day or two by slight phosphorus deficiency as may ripen of the seed. Phosphorus fertilization is a major input in crop production [4]. It participates in metabolic activities as a constituent of nucleoprotein and nucleotides and also plays a key role in the formation of energy rich bond like adenosine diphosphate (ADP) and adenosine triphosphate (ATP). Favorable response of mustard to applied P was reported by [5] and [6]. In areas where mustard is traditionally grown without P, poor growth and low yields are common features. It improves seed size, stimulates proper seed filling and increases oil content.

Boron is one of the essential micronutrient required for normal growth of most of the plants. Boron plays an important role in cell differentiation and development, regulating membrane permeability, tissue differentiation, carbohydrates and protein metabolism. It also helps in translocation of photosynthates and growth regulators from source to sink and growth of pollen grains thereby increase in seed yield of crops. Function of plant like cell wall formation, cell wall strength, cell division, fruit and seed development and sugar transport are related to boron. Availability of boron to plant is affected by variety of soil factor including soil pH, texture, moisture, temperature, oxide content, carbonate content, organic matter content and clay mineralogy [7]. Rape has much lower pollen viability and seed set when there is a lack of boron, and protein synthesis is similarly constrained. Boron deficiency hampered the growth of flowers and fruits. It partially compensates for the lack of calcium. The Brassica crop mustard responds exceptionally well to B application. Low seed output in mustard can be attributed to sterility, which results in fewer pods and seeds per pod due to boron deficiency.

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MATERIALS AND METHODS:

The experiment was conducted during Rabi 2021. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low organic carbon (0.22%), available N (171.48 kg/ha), available P (12.3 kg/ha), available K (235.7 kg/ha). The treatment viz. T1 - Phosphorus 20 kg/ha + Boron 1.0 kg/ha, T2 - Phosphorus 20 kg/ha + Boron 1.5 kg/ha, T3- Phosphorus 20 kg/ha + Boron 2.0 kg/ha, T4- Phosphorus 40 kg/ha + Boron 1.0 kg/ha, T5- Phosphorus 40 kg/ha + Boron 1.5 kg/ha, T6- Phosphorus 40 kg/ha + Boron 2.0 kg/ha, T7- Phosphorus 60 kg/ha + Boron 1.0 kg/ha, T8- Phosphorus 60 kg/ha+ Boron 1.5 kg/ha, T9-Phosphorus 60 kg/ha + Boron 2.0 kg/ha. The observations were recorded on different growth parameters at harvest viz. plant height (cm), Number of siliquae per plant, Number of seeds per siliquae, test weight(g), seed yield(t/ha) and stover yield(t/ha).

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RESULTS AND DISCUSSION

A. Growth Parameters:

Crop growth parameters in mustard were measured in terms of plant height (cm), plant dry weight at harvesting stage and are shown in Table 1. During research trail, significantly higher plant height at harvest, maximum plant height (187.59 cm) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 2.0 kg/ha which was statistically at par with treatment T8. Phosphorus application results to increase the plant height, this is possible because Phosphorus plays a crucial role, it is a key component of molecules such as phospholipids, nucleic acids and ATP. It is essential for the maintenance and transmission of energy, for the genetically transferring traits and for the development of roots. It also promotes establishment of young plants, flowering, fruiting and ripening, photosynthesis, respiration and overall plant growth. These results are consistent with that achieved from [8].

Significantly higher dry weight (37.92) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 2 kg/ha which was statistically at par with treatment T8. Maximum dry matter is observed during application of higher doses of phosphorus.This might be due to the fact that phosphorus promotes cell division and cell elongation in the plant's meristematic zone and aids in nitrogen fixation, leading to increased plant growth and development.Similar findings have also been reported by [9] .

B. Yield attributes

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The observations regarding yield and yield attributes *viz*., number of siliquae/plants, number of seeds/siliquae, seed yield, test weight, stover yield and harvest index was significantly influenced by phosphorus and boron levels are shown in Table 2. Significantly higher number of siliquae/plant (319.80), higher number of seeds/siliquae (14.60) and higher seed yield (2.61 t/ha) were observed in treatment T_9 with the application of phosphorus 60 kg/ha and boron 2.0 kg/ha and treatment with the application of phosphorus 60 kg/ha and boron 1.5 kg/ha was statistically at par. Application of phosphorus positively impacted the plant's metabolic processes, including photosynthesis, the creation of proteins and phospholipids, and other metabolic processes. The findings was in line with those reported by [10]. Boron may play a beneficial role in floral development, pollen grain production, pollen viability, pollen tube expansion for efficient pollination, and seed development, which would explain its favorable impact on yield parameters.

Significantly higher test weight (5.19 g) was observed in treatment T_9 with the application of phosphorus 60 kg/ha and boron 2.0 kg/ha and treatment T_8 with the application phosphorus 60 kg/ha and boron 1.5 kg/ha and treatment T_6 with application of phosphorus 40 kg/ha and boron 2.0 kg/ha was statistically at par. The maximum TSW recorded from plants may be result of increase in growth, yield characters and finally crop yield could be ascribed to the overall improvement in plant growth, vigor and production of sufficient photosynthesis through increased leaf area.[11]. Significantly higher stover yield (4.55 t/ha) was observed in treatment T_9 with application of phosphorus 60 kg/ha and boron 2.0 kg/ha and treatment T_8 with application of phosphorus 60 kg/ha and boron 1.5 kg/ha was statistically at par. This may be because of the enhanced phosphorus supply may have aided in the crop's early root initiation and establishment, which increased the growth characteristics. Boron nutrient intake, which in turn improved photosynthetic activity and plant vegetative growth. The quick development of mustard led to a higher production of stover as a result of adequate metabolic activity. From the (Table 2) the result was observed that increasing levels of phosphorus from 20 kg/ha to 60 kg/ha and boron levels from 1kg/ha to 2 kg/ha has significant effect on all the yield attributes such as number of siliquae/plants, number of seeds/siliquae, test weight, seed yield, stover yield and harvest index.

Fig.1. Field Preparation

Fig.2. Sowing

Fig .3. Measuring Plant Height

Fig . 4. Threshing

CONCLUSION

From the above results, Effect of phosphorus and boron levels on mustard were observed and thereby it was concluded that application of Phosphorus 60 kg/ha + Boron 2.0 kg/ha had performed better in growth parameters and yield attributes. As it was more productive. These findings are based on one season; therefore, further trails need to be conducted for further confirmation.

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Table.1 Effect of phosphorus and boron levels on growth attributes of Mustard.

Treatments	**Plant height (cm)**	**Plant dry weight (g)**
Phosphorus 20 kg/ha + Boron 1.0 kg/ha	174.17	33.32
Phosphorus 20 kg/ha + Boron 1.5 kg/ha	176.10	33.57
Phosphorus 20 kg/ha + Boron 2.0 kg/ha	176.77	34.12
Phosphorus 40 kg/ha + Boron 1.0 kg/ha	178.25	34.38
Phosphorus 40 kg/ha + Boron 1.5 kg/ha	179.32	35.37
Phosphorus 40 kg/ha + Boron 2.0 kg/ha	182.46	36.10
Phosphorus 60 kg/ha + Boron 1.0 kg/ha	182.23	35.69
Phosphorus 60 kg/ha + Boron 1.5 kg/ha	186.63	37.02
Phosphorus 60 kg/ha + Boron 2.0 kg/ha	187.59	37.92
F test	S	S
SEm(±)	0.93	0.44
CD (p=0.05)	2.78	1.32

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

Treatments	No. of Siliquae per plant	No. of seeds per Siliquae	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
Phosphorus 20 kg/ha + Boron 1.0 kg/ha	290.93	13.33	4.47	1.85	3.86	32.36
Phosphorus 20 kg/ha + Boron 1.5 kg/ha	295.07	13.47	4.63	1.94	3.96	32.92
Phosphorus 20 kg/ha + Boron 2.0 kg/ha	297.67	13.53	4.70	1.99	4.05	32.94
Phosphorus 40 kg/ha + Boron 1.0 kg/ha	301.00	13.60	4.76	2.13	4.13	34.08
Phosphorus 40 kg/ha + Boron 1.5 kg/ha	304.47	13.67	4.91	2.24	4.24	34.52
Phosphorus 40 kg/ha + Boron 2.0 kg/ha	312.40	13.87	5.07	2.38	4.38	35.23
Phosphorus 60 kg/ha + Boron 1.0 kg/ha	308.40	13.80	4.89	2.32	4.33	34.91
Phosphorus 60 kg/ha + Boron 1.5 kg/ha	317.87	14.40	5.09	2.52	4.51	36.09
Phosphorus 60 kg/ha + Boron 2.0 kg/ha	319.80	14.60	5.19	2.61	4.55	36.47
F test	S	S	S	S	S	S
SEm (±)	1.99	0.09	0.06	0.04	0.02	0.40
CD (5%)	5.96	0.27	0.18	0.11	0.06	1.20