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Effect of potassium and boron on growth and yield of mustard (*Brassica juncea* L.)

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Abstract
Mustard (*Brassica juncea* L.) is an important oilseed crop cultivated worldwide. The present study was conducted to evaluate the effect of potassium and boron on the growth and yield of lentil. A field experiment was conducted using a randomized complete block design with three replications. The treatments included different combinations of Potassium levels (20 kg/ha, 30 kg/ha, and 40 kg/ha) and boron (1 kg/ha, 1.5 kg/ha and 2 kg/ha). The results indicated that the application of potassium and boron significantly influenced the growth and yield parameters of mustard. The combined application of Potassium at 40 kg/ha along with Boron 2 kg/ha (Treatment 9) significantly increased plant height, number of branches/plant, plant dry weight, number of siliqua/plant, number of seeds/siliqua, Test weight, seed yield and stover yield. These findings suggest that the integrated use of potassium and boron can enhance the growth and yield of mustard, thereby improving its productivity and economic returns for farmers. The result reported the application of Potassium at 40 kg/ha along with Boron 2 kg/ha (Treatment 9) recorded that the plant height (184.44 cm), branches/plant (14.80), dry weight (24.01 g/plant) and yield attributes siliquae/plant (125.75), Seeds/siliquae (15.13 g) Test weight (3.41), Seed yield (2135.15 kg/ha) and Stover yield (4043.38 kg/ha).

Keywords: Boron, musturd, potassium, growth and yield

Introduction

Indian mustard Known by its common name, mustard, Indian mustard (Brassica juncea L.) is a member of the Brassicaceae family. Old French mostarde and Anglo-Norman mustarde are the sources of the word "mustard" (contemporary French is moutarde). The word "young wine" (mustum) in Latin is the source of the first element. Originally, pulverized seeds were mixed with must to make the condiment. The Latin word "ardens" (hot, burning) is also the source of the second ingredient. In business, medicine, and cuisine, mustard oil is employed. In addition to being rich in omega-3 fatty acids, mustard seed has vitamins and minerals.

Right now, rapeseed-mustard is India's third-most important oilseed crop, behind soybean and peanuts. India is the biggest oilseed producer, importer, and consumer in the world. Raabi (winter crop): One of the nine principal oilseeds cultivated in India is Indian mustard (Brassica juncea L.). In order to become self-sufficient, rapeseed-mustard output must rise due to the rising imbalance between supply and demand.

In India, 9.80 mha of rapeseed-mustard are grown, yielding 11.4 mt of product and 1179 kg/ha of productivity (Agricultural Statistics at a glance, 2021-22). The states that cultivate the most rapeseed and mustard are Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, and West Bengal. Together, these states account for 82% of the nation's total rapeseed and mustard acreage and 85% of its total production.

One of the crucial elements that most field crops need in smaller amounts is boron, which has a significant impact on crop productivity despite being needed in smaller amounts. Many data indicate mustard's favorable response to boron fertilizer. In mustard, farmers often apply smaller amounts of N, P, and K and do not use boron fertilizer. Boron plays a major role in seed yield, especially in areas where soil contains insufficient amounts of B. Additionally, they reported that boron boosted mustard output and the amount of siliqua. In general, the brassica group has a high boron requirement.

Boron was found to significantly boost seed set and pod quantity (Sharma 2006) [3]. Boron treatment results in a 16–69% increase in seed production. Crop development and output are impacted by either an excess or a shortage of boron. Boron deficiency limits the body's ability to absorb water and metabolize carbohydrates, which in turn impacts seed and pod production and lowers yield. A significant increase in seed yield can be achieved by using boron, which is essential for cell differentiation and development, photosynthesis, translocation of growth regulators from source to sink, and pollen grain expansion. The formation of viable pollen grains in the flower and, eventually, the yield are impacted by boron toxicity or lack. With nutrient addition and tillage modification, there is still room to grow the productivity of mustard and rapeseed in the cultivation practices.

In terms of nutrients required by plants, potassium (K) is deemed essential after nitrogen. It is also known as "the quality nutrient" because of its role in several physiological, chemical, and biological processes in plants. Potassium controls stomata's opening and closing, which controls CO2 intake and improves photosynthesis. It causes the production of Adenosine Triphosphate (ATP) by activating key biological enzymes. Other chemical and physiological functions, such the excretion of waste compounds by plants, depend on ATP for energy. It contributes to the osmoregulation of other salts and water in plant tissues and cells. Additionally, plants use potassium to synthesize carbohydrates and proteins. In addition to yield advantage, potassium influences the connection between plants, soil, and water, which helps plants become more drought-tolerant. Consequently, it is necessary in high concentrations for plants to grow and develop properly. Potassium activates around 60 different enzymes in plants.

These enzymes directly contribute to the maintenance of turgor, which lessens wilting and water loss while enhancing drought tolerance. Potassium may have decreased transpirational water loss in plants. According to a number of studies, plants with inadequate potassium levels transpire more than plants with sufficient potassium levels when they are under moisture stress. In addition, potassium facilitates the transfer of sugars and starches throughout plants, encourages the growth of roots, and supports photosynthesis. Potassium controls the xylem and phloem's ability to carry nutrients and water throughout the plant. Similarly, Jakli *et al*. (2016) [18] reported that potassium (K) plays a significant effect in lowering plant stress, especially moisture stress, and enhances agricultural water use efficiency (WUE).

Materials and Methods

The investigation was carried out at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture Science and Technology (SHUATS), Naini, Prayagraj, UP, during rabi 2023-24. The treatment consists of T_1: Potassium 20 kg/ha + Boron 1 kg/ha, T_2: Potassium 20 kg/ha + Boron 1.5 kg/ha, T_3: Potassium 20 kg/ha + Boron 2 kg/ha, T_4: Potassium 30 kg/ha + Boron 1 kg/ha, T_5: Potassium 30 kg/ha + Boron 1.5 kg/ha, T_6: Potassium 30 kg/ha + Boron 2 kg/ha, T_7: Potassium 40 kg/ha + Boron 1 kg/ha, T_8: Potassium 40 kg/ha + Boron 1.5 kg/ha, T_9: Potassium 40 kg/ha + Boron 2 kg/ha, T_{10}: Control (80:40:40) NPK kg/ha. The experiment was laid out in Randomized Block Design, with 10 treatments replicated thrice. The observations were recorded for Plant height, Number of branches/plant, Dry weight of plant, Crop growth rate, Relative growth rate, Number of siliqua/plant, Number of seeds/siliqua, Test weight, seed yield, stover yield. The collected data was subjected to statistical analysis by analysis of variance method.

Results and Discussion

Plant Height: At harvest, treatment-9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha recorded significant and higher plant height (184.44 cm). However, treatment-8 Potassium 30 kg/ha + Boron 2 kg/ha was found to be statistically at par with treatment- 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Plant Dry Weight

At harvest, treatment 9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha recorded significant and maximum plant dry weight (24.01 g). However, the treatment 8 Potassium 30 kg/ha + Boron 2 kg/ha and treatment 7 Potassium 20 kg/ha + Boron 2 kg/haa. were found to be statistically at par with treatment 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Branches per plant

At harvest, treatment 9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha recorded significant and maximum number of branches/plant (14.8). However, the treatment 8 Potassium 30 kg/ha + Boron 2 kg/ha and treatment 7 Potassium 20 kg/ha + Boron 2 kg/ha were found to be statistically at par with treatment 9 Potassium 40 kg/ha + Boron 2 kg/ha

Siliqua per plant

Treatment 9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha recorded significantly higher number of siliqua/plant (125.75), which was significantly superior over rest of the treatments. However, treatment-8 Potassium 30kg/ha + Boron 2 kg/ha was found to be statistically at par with treatment- 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Seeds per siliqua

significant and maximum number of seeds/siliqua (15.13) was observed in treatment-9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha, which was significantly superior over rest of the treatments. However, treatment-8 Potassium 30 kg/ha + + Boron 2 kg/ha was found to be statistically at par with treatment- 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Test weight

significantly higher test weight highest (3.41 g) was recorded in treatment 9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha, though there was non-significant difference among the treatments.

Seed yield

significant and higher seed yield (2135.15 kg/ha) was observed in treatment-9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha, which was significantly superior over rest of the treatments. However, treatment-8 Potassium 30 kg/ha + Boron 2 kg/ha was found to be statistically at par with treatment- 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Stover yield

treatment 9 with application of Potassium 40 kg/ha along with Boron 2 kg/ha recorded significant and higher stover yield (4043.38 kg/ha), which was significantly superior over rest of the treatments. However, treatment-8 Potassium 30 kg/ha + Boron 2 kg/ha was found to be statistically at par with treatment- 9 Potassium 40 kg/ha + Boron 2 kg/ha.

Table 1: Influence of Sulphur and Boron on growth and yield attributes of lentil

S. No.	Treatments	Plant height (cm)	Dry weight (g)	Branches/ plant	Siliqua/ plant	Seeds/ siliqua	Test weight	Seed yield	Stover yield
1.	Potassium 20 kg/ha + Boron 1 kg/ha	171.96	21.65	26.07	104.18	9.44	2.97	1005.69	3634.50
2.	Potassium 20 kg/ha + Boron 1.5 kg/ha	167.17	21.28	25.80	109.83	10.74	2.99	1203.18	3665.00
3.	Potassium 20 kg/ha + Boron 2 kg/ha	181.31	23.00	27.33	110.84	12.15	3.04	1385.22	3892.50
4.	Potassium 30 kg/ha + Boron 1 kg/ha	180.35	22.80	27.73	114.16	12.98	3.05	1522.42	3862.50
5.	Potassium 30 kg/ha + Boron 1.5 kg/ha	176.89	22.48	28.20	119.50	12.87	3.22	1673.89	3814.50
6.	Potassium 30 kg/ha + Boron 2 kg/ha	177.11	22.67	28.73	121.50	12.67	3.15	1626.31	3843.00
7.	Potassium 40 kg/ha + Boron 1 kg/ha	182.34	23.48	28.97	121.83	13.73	3.24	1796.02	3964.50
8.	Potassium 40 kg/ha + Boron 1.5 kg/ha	182.82	23.65	29.07	124.83	14.04	3.33	1936.63	3990.00
9.	Potassium 40 kg/ha + Boron 2 kg/ha	184.44	24.01	29.67	125.75	15.13	3.41	2135.15	4043.38
10.	Control (RDF) – 80:40:40 NPK kg/ha	154.00	20.71	25.73	89.27	8.89	2.83	757.23	3399.83
	F - test	S	S	S	S	S	NS	S	S
	S.Em (±)	5.60	0.67	0.45	7.29	0.56	0.19	132.49	0.12
	CD (p=0.05)	16.64	1.99	1.33	21.66	1.66	-	393.58	0.36

Conclusion

In conclusion, the study demonstrated significant differences in various growth and yield parameters among different treatments. The application of Potassium at 40 kg/ha along with Boron 2 kg/ha (Treatment 9) significantly resulted in superior plant height, dry weight, number of branches per plant, number of siliqua per plant, number of seeds per siliqua, Test weight, seed yield, and stover yield compared to other treatments, including the control. These findings suggest that the utilization of Potassium and boron enhances plant growth, nutrient uptake, and ultimately, seed yield. The recorded improvements in growth and yield parameters can be attributed to the favorable nutritional. These results align with previous research, highlighting the importance of innovative agricultural practices in maximizing crop productivity.

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