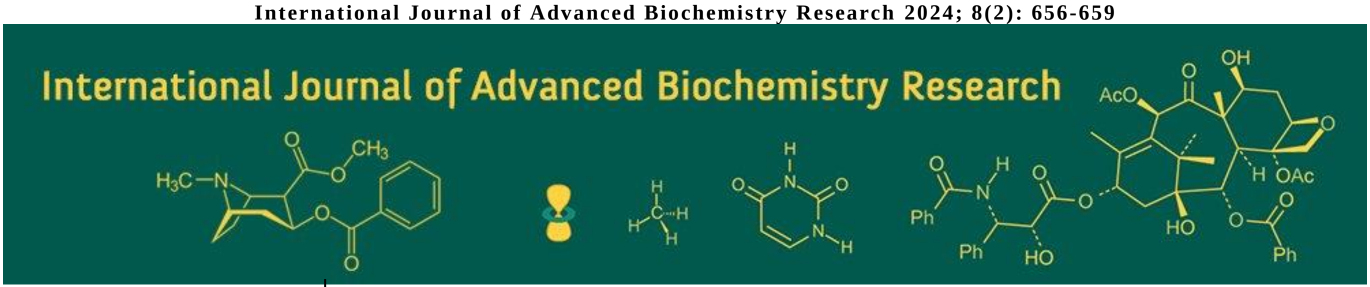

ISSN Print: 2617-4693
ISSN Online: 2617-4707
IJABR 2024; 8(2): 656-659
www.biochemjournal.com
Received: 16-12-2023
Accepted: 20-01-2024

Raksha Patle
Department of Soil Science and Agricultural Chemistry, A.K. S. University, Satna, Madhya Pradesh, India

Atul Kumar Singh
Department of Soil Science and Agricultural Chemistry, A.K. S. University, Satna, Madhya Pradesh, India

Corresponding Author:
Raksha Patle
Department of Soil Science and Agricultural Chemistry, A. K. S. University, Satna, Madhya Pradesh, India

Impact of boron on yield, nutrient uptake and seed quality of mustard (*Brassica juncea* L.)

Raksha Patle and Atul Kumar Singh

DOI: https://doi.org/10.33545/26174693.2024.v8.i2h.649

Abstract
A field experiment was conducted during winter season of 2022-23 at the Research Farm, A. K. S. University, Satna (M.P.) to study the impact of boron on yield, nutrient uptake and seed quality of mustard. It was concluded that amongst the applied boron levels, 2.75 kg B/ha proved the best dose for growing mustard var. Pusa Bold for Kymore plateau (Satna region) of Madhya Pradesh. This 2.75 kg boron dose recorded maximum yield - attributes. Thus, the maximum seed yield was 16.94 q/ha, total uptake of N (80.20 kg/ha), P (23.24 kg/ha) and K (67.57 kg/ha) as well as seed oil and seed protein was found upto 41.73 and 19.78%, respectively. The second and third best boron levels were 2.50 and 2.25 kg/ha, respectively with respect to above mentioned parameters.

Keywords: Boron, yield, nutrient uptake, seed quality, mustard, *Brassica juncea* L.

Introduction
Twenty to thirty percent of total oilseed production in the nation comes from mustard, the second-biggest oilseed crop. For great seed quality and productivity, it must have the best nourishment possible. Boron is essential to oil seed crop phenology.

Oil seed crops respond effectively to applied sulfur and boron, and boron plays a significant role in the production phenology of these crops (Karthikeyan and Shukla 2008) [5]. 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.

Reduced boron, starch, protein, and oil content as well as elevated sugar and phenol contents were indicators of declining seed quality. For crops produced in soils where available boron falls below the crucial limit of 0.5 mg kg^{-1}, boron application is important (Ramana *et al.* 2016) [7].

Low B seed quality resulted in a decline in carbohydrate, protein, and oil content as well as an increase in sugar and phenol contents. Oilseed crops frequently have B deficiencies as a result of increased cropping intensity. All crops typically respond to boron application in soils lacking in boron, but oilseeds respond more strongly. Given the dearth of knowledge of oilseeds to B in the Madhya Pradesh region of Satna.

Materials and Methods
The field experiment was conducted during the winter season of 2022-23 at A. K. S. University, Satna. The soil was silty – clay – loam with a pH of 7.3, electrical conductivity of 0.25 dS/m, and organic carbon of 0.58%. The treatments included 12 levels of boron, with the mustard var. Pusa Bold sown on 20 October 2022 at 7 kg/ha in rows of 30 cm. The boron levels were applied as basal through borax, with a common dose of 60 kg N, 30 kg P2O5, 20 kg K2O/ha, and 20 kg S applied in all treatments. The crop was raised according to the recommended package of practices and harvested in March 2023. The oil percentage in seeds was determined using Soxhlet's extraction method, and the crude protein in seeds was estimated using micro-Kjeldahl's method. .

Results and Discussion

Vegetative growth parameters

Results on the periodical changes in plant growth (Table 1) indicated that the plant height, in general. was very fast between 30 and 60 DAS stage, thereafter the increase became slow up to days stage. The fast vegetative growth up to 60 days stage on plant height was because of the fact that the plant growth activities i.e. active growth phases are genetically controlled and takes a certain period before they enter into the reproductive phase.

As regards with the applied boron levels, 2.75 kg B/ha recorded significant rise in plant height at 30, 60 and 90 days stages of plant growth i.e. 16.72, 113.65 and 138.10 cm, respectively. This was followed by the lower levels of boron upto 0.25 B/ha. In contrast, the control treatment recorded the lowest plant height 13.36, 108.55 and 133.92 cm at the same respective growth intervals. The increased plant height due to increased boron levels may be because boron takes part in the active photosynthesis, which ultimately helps towards increase in plant height. The similar results have been supported by Singh *et al.* (2019) [11], Solanki *et al.* (2018) [12], Verma *et al*. (2019) [14], and Singh *et al.* (2020) [10].

Boron is crucial for carbohydrates transport, cell wall metabolism, membrane stability, phenol metabolism, and lignin synthesis. Its deficiency restricts stomata opening and transpiratory water loss, leading to increased solute leakage. Boron is associated with meristematic activity, auxin, cell-well, protein, and pectin metabolism, maintaining water relations, sugar translocation, fruiting processes, and phenolase inhibitions. It is closely related to calcium's functions in plants and is suggested to be necessary for the lignin polymerization process.

Yield-attributing parameters

The highest boron level up to 2.75 kg/ha increased all the yield attributes of mustard up to significant extent over the preceding boron levels. There were significantly highest 163.5 siliquae / plant, 17.8 seeds / siliqua, 5.74 g test weight of 1000-seeds and 14.39 g seed weight/plant. (Table 1).

The second and third best boron level was 2.50 and 2.25 kg/ha. The effect of boron levels. On yield attributes was decreased with the decrease in the supply of boron up to only 0.25 kg/ha. In control treatment the yield-attributes were found lowest (148.6 siliquae / plant, 13.6 seeds siliqua, 4.72 g test weight and 10.53 g seed weight /plant).

The significant role that sulfur plays in regulating photosynthesis, as well as the enhanced metabolic activities that promote chlorophyll formation and photosynthesis on the one hand and root development and accelerated nutrient absorption on the other, may be the cause of the higher numbers of siliquae/plant, seeds/siliqua, 1000-seed weight, and seed weight/plant. Additionally, this has improved the balance between translocation and photosynthesis, increased nutrient uptake, and eventually raised mustard yield-related characteristics.

In plants, boron is crucial for the growth and differentiation of sucrose. It somewhat compensates for the calcium deficit while also aiding in the regular growth of plants and the soil's ability to absorb nitrogen. Boron aids in the creation of pollen grains, flowers, and roots. Verma and others (2012) [13]. According to Singh *et al*. (2019) [11], Verma *et al*. (2019) [14], and Singh *et al*. (2020) [10], the current results concur with the conclusions of other researchers.

Productivity parameters of mustard

According to the study, mustard plants' seed output (16.94 q/ha) and straw yield (33.9 q/ha) were greatly enhanced by 2.75 kg B/ha of boron. enhanced vegetative growth and a physiological involvement in enhanced synthesis and biomass partitioning were cited as the causes of this rise. The improved metabolism of carbohydrates and photosynthesis were the primary causes of the rise in seed output. Borax increases anthers' ability to produce pollen, which increases the amount of seed produced per siliquae. By regulating phosphorylation processes, decreasing assimilate consumption, and speeding up photosynthesis removal, it also has a positive impact on plants' photosynthetic output. Protein synthesis, the creation of chlorophyll, and the metabolism of carbohydrates all depend on sulfur and boron. Improved yield qualities are mostly responsible for the increase in seed production, which is consistent with other studies on mustard and sesame. The results are consistent with previous research by Verma *et al*. (2019) [14], and Singh *et al*. (2020) [10].

Nutritional seed quality

Application of highest level of boron (2.75 kg /ha) enhanced the seed oil content upto maximum extent (41.73%), the oil yield went up to 706.9 kg/ha. Similarly protein content in seed was also found highest (19.73%) due to 2.75 kg B/ha. The protein yield was found upto 334.2 kg/ha under the highest level of boron. Both these quality parameters were declined under the decreased supply of boron minimum upto 0.25 kg/ha. Accordingly, the oil content and oil yield was lowest 38.82% and 515.5 kg/ha, respectively. Similarly seed protein was lowest (17.60 %) and seed protein yield was only 233.7 kg/ha under the lowest dose of boron (0.25 kg/ha).

The production of fatty acids and their esterification by sulfur and other nutrients may be the cause of the increase in mustard oil content. It is also essential for the synthesis of protein, amino acids, and vitamins like thiamine and biotin. This is consistent with earlier research conducted by Yadav *et al*. (2018) [15], Verma *et al*. (2019) [14]. The addition of boron increases the protein content of mustard seeds as well because it is necessary for the production of uracil, an important RNA molecule, which is involved in protein synthesis in meristematic tissues. Tissue development can be hampered by protein synthesis, thus a steady supply of B is required to compensate.

Total nutrients uptake by mustard per hectare

The total N, P, and K uptake by seed and straw was improved by applying the greatest level of 2.75 kg B/ha (Table 2). The total biomass (seed + straw) generated at the maximum boron level was 50.92 q/ha, removing the maximum amount of 80.20 kg N, 23.24 kg P, and 67.57 kg K. Conversely, the control treatment (T1) yielded the lowest total biomass of 54.56 kg N/ha, 14.22 kg P/ha, and 47.27 kg K/ha, producing just 38.87 q/ha. The higher yields of seeds and straw as well as higher N, P, and K contents in mustard seed and straw under these treatments may be the cause of the better uptake of NPK nutrients under higher boron levels.

It's possible that higher nutrient production and content are the cause of the increased nutrient intake. Numerous enzymes and protein synthesis depend on boron for structural and regulatory functions, which has an immediate impact on how well nutrients are absorbed from the soil. According to Singh *et al.* (2017) [16], crop output and nutrient concentrations in crop plants determine how well a crop is absorbed. The improved nutrient uptake by sunflower and mustard reported by Jaiswal *et al.* (2015) [4] is consistent with the rise in these parameters brought about by the application of B.

The current results support the conclusions of multiple researchers. Singh *et al.* (2019) [11], Verma *et al.* (2019) [14] and Singh *et al.* (2020) [10].

Table 1: Growth, yield – attributes and yield of mustard as influenced by boron levels

Tr. No.	Treatments	Plant height (cm)			Siliquae/plant	No. of seeds/siliqua	1000 Seed weight. (g)	Seed weight./plant (g)	Seed yield (q/ha)	Straw yield (q/ha)
		30 DAS	60 DAS	90 DAS	90 DAS					
T_1	Control	13.36	108.55	133.92	148.62	13.62	4.72	10.53	12.54	26.33
T_2	0.25 kg boron/ha	13.74	109.46	134.55	151.23	14.34	5.06	11.70	13.28	27.82
T_3	0.50 kg boron/ha	13.92	109.79	134.88	152.65	14.97	5.18	11.92	14.20	29.45
T_4	0.75 kg boron/ha	14.27	110.12	135.10	153.81	15.23	5.21	12.36	14.59	29.79
T_5	1.00 kg boron/ha	14.55	110.85	135.42	154.74	15.85	5.27	12.74	14.82	30.60
T_6	1.25 kg boron/ha	14.83	111.17	135.86	155.45	16.08	5.28	12.93	14.97	31.18
T_7	1.50 kg boron/ha	15.10	111.86	136.12	157.26	16.37	5.38	13.15	15.28	31.80
T_8	1.75 kg boron/ha	15.24	112.16	136.59	159.68	16.73	5.45	13.40	15.69	32.24
T_9	2.00 kg boron/ha	15.56	112.43	136.92	160.37	16.92	5.57	3.76	15.92	32.87
T_{10}	2.25 kg boron/ha	15.73	112.87	137.34	160.95	17.35	5.63	13.95	16.35	33.12
T_{11}	2.50 kg boron/ha	16.31	113.24	137.85	162.23	17.56	5.68	14.22	16.56	33.63
T_{12}	2.75 kg boron/ha	16.72	113.65	138.10	163.52	17.85	5.74	14.39	16.94	33.98
	S. Em ±	0.12	0.18	0.22	0.28	0.08	0.05	0.16	0.12	0.20
	C.D. (P = 0.05)	0.34	0.53	0.63	0.82	0.24	0.14	0.45	0.36	0.58

Table 2: Seed quality and nutrient contents and uptake of mustard as influenced by boron levels

Tr. No.	Treatments	Oil content (%)	Oil yield (kg/ha)	Protein yield (q/ha)	Protein content (%)	N-content (%)		P-content (%)		K-content (%)		Total nutrients uptake		
						Seed	Straw	Seed	Straw	Seed	Straw	N	P	K
T_1	Control	38.50	482.8	217.3	17.33	3.07	0.61	0.63	0.24	0.83	1.40	54.56	14.22	47.27
T_2	0.25 kg boron/ha	38.82	515.5	233.7	17.60	3.12	0.67	0.65	0.26	0.86	1.45	60.07	15.86	51.76
T_3	0.50 kg boron/ha	39.15	555.9	252.9	17.81	3.12	0.68	0.64	0.26	0.85	1.47	64.33	16.75	55.36
T_4	0.75 kg boron/ha	39.37	574.4	264.1	18.10	3.14	0.68	0.67	0.27	0.87	1.47	66.07	17.82	56.48
T_5	1.00 kg boron/ha	39.65	587.6	271.8	18.34	3.15	0.69	0.67	0.28	0.87	1.48	67.79	18.50	58.18
T_6	1.25 kg boron/ha	39.90	597.3	278.1	18.58	3.15	0.70	0.68	0.28	0.88	1.49	69.00	18.91	59.63
T_7	1.50 kg boron/ha	40.22	614.6	288.2	18.86	3.16	0.70	0.68	0.30	0.89	1.49	70.54	19.93	60.98
T_8	1.75 kg boron/ha	40.78	639.8	297.2	18.94	3.18	0.71	0.70	0.30	0.89	1.48	72.78	20.65	61.68
T_9	2.00 kg boron/ha	41.12	654.6	305.7	19.20	3.19	0.72	0.71	0.31	0.90	1.50	74.45	21.49	63.64
T_{10}	2.25 kg boron/ha	41.27	674.8	316.5	19.36	3.19	0.74	0.72	0.32	0.91	1.49	76.67	22.37	64.23
T_{11}	2.50 kg boron/ha	41.48	686.9	324.1	19.57	3.20	0.76	0.72	0.33	0.92	1.50	78.56	23.02	65.69
T_{12}	2.75 kg boron/ha	41.73	706.9	334.2	19.73	3.21	0.76	0.73	0.32	0.94	1.52	80.20	23.24	67.57
	S. Em ±	0.17	0.83	0.90	0.11	0.02	0.01	0.013	0.009	0.02	0.03	0.40	0.31	0.57
	C.D. (P = 0.05)	0.48	2.41	2.60	0.32	0.05	0.03	0.039	0.026	0.05	0.08	1.14	0.91	1.64

Conclusion

In conclusion, the study's findings underscore the significant impact of boron levels on various growth parameters, yield attributes, productivity, nutritional seed quality, and total nutrient uptake in mustard plants. Notably, the fast vegetative growth observed up to the 60-day stage is attributed to genetic factors dictating the plant's growth phases. Application of boron, particularly at 2.75 kg/ha, significantly enhances plant height, yield attributes, productivity, and nutritional quality of seeds, resulting in improved biomass accumulation and nutrient uptake. Boron's involvement in vital physiological processes such as photosynthesis, carbohydrate transport, protein synthesis, and nutrient absorption highlights its indispensable role in mustard cultivation. The consistent correlation between boron application and improved plant performance resonates with findings from prior studies, further supporting the importance of optimizing boron levels for enhanced mustard production. These results emphasize the potential for strategic boron management to boost agricultural productivity and nutritional quality, offering valuable insights for sustainable mustard cultivation practices.

References

1. A.O.A.C. American Oil Chemists Society 2nd Edn. Method No. AC. 3-44. American Oil Chemists Society, U.S.A. Edited by V.C. Methlenbaczer, T.H. Hopper and E.M. Sance, 1964, 1.
2. A.O.A.C. Official Methods of Analysis 14th Edn. Association of Official Agricultural Chemists, Washington, D.C; c1997.
3. Dwivedi AK, Bapat PN. Sulphur-phosphorus as interaction on the synthesis of nitrogenous fractions and oil in soybean. Journal Indian Society of Soil Science. 1998;46(2):254-257.
4. Jaiswal AD, Singh SK, Singh YK, Singh SS, Yadav S. N., Effect of sulphur and boron on yield and quality of mustard (*Brassica Juncea* L.) grown on Vindhyan red soil. Journal of the Indian Society of Soil Science. 2015;63:362-364.
5. Karthikeyan K, Shukia LM. Effect of boron-sulphur interaction on their uptake and quality parameters of mustard (*Brassica juncea* L.) and sunflower (*Helianthus annus* L). Journal of the Indian Society of Soil Science. 2008;56(2):225-230.

6. Mathew J, George S. Synergistic influence of sulphur and boron enhancing the productivity of sesame (*Sesamum indicum* L.) grown in an Entisol of Kerala. Journal of the Indian Society of Soil Science. 2013;61:122-127.
7. Ramana PV, Gladis R, Nagula S. Response of black pepper to foliar application of magnesium and boron. Annals of Plant and Soil Research. 2016;18(3):287-290.
8. Rathore SS, Shekhawat K, Kaudpal BK, Premi OP, Singh SP, Singh GC, *et al*. Sulphur management for increased productivity of Indian mustard. Annals of Plant and Soil Research. 2015;17(1):1-12.
9. Sankaran A. Laboratory Manual for Agricultural Chemistry, Agriculture College, Baptala (A.P.); c1973. p. 163-165.
10. Singh Ranjeet, Singh Har Mohan Yadav, Singh Vinay. Effect of sulphur and boron on yield, quality and uptake of nutrients by mustard (*Brassica juncea*) grown on alluvial soil. Annals of Plant and Soil Research. 2020;22(2):123-127
11. Singh Ranvir, Singh Yogesh, Singh Sarika. Yield, quality and nutrient uptake of Indian mustard (*Brassica juncea*) under sulphur and boron nutrition Annals of Plant and Soil Research. 2019;19(2):227-231
12. Solanki VPS, Singh Jagpal, Singh Vinay. Effect of zinc and boron nutrition on productivity and uptake of nutrients in onion (*Alliun cepa*). Annals of Plant and Soil Research. 2018;20(2):214-217.
13. Verma Chandra Kumar, Prasad Kedar, Yadav DD. Studies on response of sulphur, zinc and boron levels on yield, economics and nutrients uptake of mustard Crop Res. 2012;44(1&2):75-78.
14. Verma S, Pandi SA, Mansood A, Khan NA. Ethylene supplementation increase PS II efficiency and alleviates chromium inhabited photosynthesis through increased nitrogen and sulphur assimilation in mustard. Journal of Plant Growth Regulation. 2019;37(4):1300-1317.
15. Yadav Vinita, Yadav MS, Prasad FM. Effect of gibberellic acid and boron on yield and biochemical parameters of tomato (*Lycopersicon esulentum*) fruits. Annals of Plant and Soil Research. 2018;20(4):401-404.
16. Singh T, Sharma S, Nagesh S. Socio-economic status scales updated for 2017. Int J Res Med Sci. 2017 Jul;5(7):3264-3267.