International Journal of Plant & Soil Science

Volume 37, Issue 2, Page 269-275, 2025; Article no.IJPSS.130994
ISSN: 2320-7035

Effect of Different Levels of Boron for Improving the Yield and Concentration of Boron in Wheat Crop (*Triticum aestivum* L.)

Anshuman Dwivedi [a], Vinay Kumar [b++] and Deepak Kumar Dwivedi [c*]

[a] Department of Agricultural Chemistry and Soil Science, Udai Pratap Autonomous College, Varanasi, 221002, (U.P.), India.
[b] Department of Soil science and Agricultural chemistry, JRS, Katihar, Bihar Agricultural University, Sabour, Bhagalpur, Bihar, India.
[c] School of Natural Resource Management, College of Post-Graduate Studies in Agricultural Sciences, (Central Agricultrual University, Imphal), Umiam, 793 103, Meghalaya, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.9734/ijpss/2025/v37i25329

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://pr.sdiarticle5.com/review-history/130994

Original Research Article

Received: 05/12/2024
Accepted: 07/02/2025
Published: 22/02/2025

ABSTRACT

A field experiment was conducted to study the "Effect of Different Levels of Boron for Improving the Yield and concentration of Boron in wheat Crop (*Triticum aestivum* L.) during the Winter (*Rabi*) Season of 2012-2013 at the Research Farm of the Department of Agricultural Chemistry and Soil

---

++Assistant professor cum Junior Scientist;
**Corresponding author: E-mail: deepakdwivedi.soil@gmail.com;*

Cite as: *Dwivedi, Anshuman, Vinay Kumar, and Deepak Kumar Dwivedi. 2025. "Effect of Different Levels of Boron for Improving the Yield and Concentration of Boron in Wheat Crop (Triticum Aestivum L.)". International Journal of Plant & Soil Science 37 (2):269-75. https://doi.org/10.9734/ijpss/2025/v37i25329.*

Science, Udai Pratap Autonomous College, Varanasi, Uttar Pradesh, India. Six treatments, *viz*. T_0: Control (no input), T_1: B @ 0.5 kg ha^{-1}, T_2: B @ 1.0 kg ha^{-1}, T_3: B @ 1.5 kg ha^{-1}, T_4: B @ 2.0 kg ha^{-1}, T_5: B @ 2.5 kg ha^{-1}, and N, P_2O_5, and K_2O were applied at the recommended dose @ 120: 80: 60 kg ha^{-1}, respectively, were comprised in a randomized block design (RBD) with the three replications. The results revealed that different levels of boron significantly improved the yield and yield-attributing characters of wheat. Maximum grain yield (37.70 q ha^{-1}), straw yield (47.13 q ha^{-1}), total dry matter (84.48 q ha^{-1}) and dry weight of root g^{-3} plant at 60 DAS (0.318) were recorded with Boron @ 2 kg ha^{-1}. Moreover, maximum dry weight of $shoot^{-3}$ plant at 60 DAS (1.91) was observed with boron at 2.5 kg ha^{-1}). Maximum B concentration in 3^{rd} leaf (40.63 mg kg^{-1}) B concentration in grain (25.37 mg kg^{-1}) B concentration in straw (30.87 mg kg^{-1}) B concentration in root (160.20 mg kg^{-1}) was recorded under Boron @ 2.0 kg ha^{-1}.

Keywords: Wheat; yield; level of boron; dry matter.

1. INTRODUCTION

"Wheat (*Triticum aestivum* L.) is cultivated in nearly 17% of agricultural lands. It is one of the most important cereal crops which offer 85% of calories and 82% of protein to the world's population" (Khalid et al., 2023). "Wheat is cultivated throughout the globe because of its distinct capability to adapt to various soil types and climates" (Erenstein et al., 2022). "Wheat followed by Maize, are the two most grown crops globally" (Erenstein et al*.,* 2021). "The average total Boron concentration in soils in the range of 20-200 ppm dry weight, most of which is unreachable to plants" (Mengel & Kirkby, 2001). "The available concentrations also vary greatly from soil to soil. Most soils have less than 10 ppm B and many areas of land are poor in B" (Woods, 1994; Manikant, 2002). Furthermore, the preponderance of this Boron is immobilized in rocks and not ready available for plants (Alamer, 2025).

Boron (B) is one of the essential micronutrient for plant growth and development (Warington, 1923), it is taken up by plant roots as boric acid (H_3BO_3) via passive diffusion via the membranes (Tanaka & Fujiwara, 2008). It plays crucial role in plant physiology mainly in nucleic acid metabolism, sugar transport, cell wall stability, enzyme activation, (Kohli et al., 2023; Li et al., 2023; Pereira et al., 2021), and improves crop quality parameters *viz*., vitamin C, starch, sugars, TSS etc. (Rerkasem et al., 2020) and also involve in pollen tube formation, cell division, formation of cell wall, cell elongation (Gupta & Solanki, 2013). "The limited range between boron deficiency and toxicity in the soil solution presents a considerable difficulty for sustaining sufficient boron levels for optimal plant growth" (Brdar-Jokanovic, 2020). "Moreover, irregularities in B levels may significantly hamper crop productivity and subsequently impact human health" (Nadeem et al., 2019). "Thus, accurate management of B fertilization into the soil is crucial to maintain both plant and human nutrition" (Aytop et al., 2023; Brdar-Jokanovic, 2020).

Therefore, boron deficiency is one of the essential determining factors for growth and yield of crop plants including wheat. Wheat is grown widely for its cereal grains and is consumed worldwide as food.

2. MATERIALS AND METHODS

A field experiment was conducted at Research Farm of the Department of Agricultural Chemistry and Soil Science, Udai Pratap Autonomous College, Varanasi, Uttar Pradesh, India, during the winter (*rabi*) Season of 2012-13. The experiment site lies between 25.18ºN, 80.03º E and 128.93 meters above mean sea level. This location is characterized by a subtropical and semi-arid to sub-humid climate with hot and dry summer and cold winter. The experimental soil was alluvial, sandy loam with low to moderate water holding capacity. The soil has 7.6 pH and medium in organic carbon (0.54%), EC 0.29dSm^{-1} and low in available nitrogen (214.80 kg ha^{-1}), low in available phosphorus (16.0 kg ha^{-1}) and potassium (130 kg ha^{-1}), and available sulphur (12.40kg ha^{-1}). The soil samples were collected randomly to analyze the physico-chemical properties from the experimental site at a depth of 0-15 cm before conducting the experiment. The experiment was laid in randomized complete block design (RBD) comprising six treatments *viz*. T_0: Control (no input), T_1:Boron @ 0.5 kg ha^{-1}, T_2: Boron @ 1.0 kg ha^{-1}, T_3: Boron @ 1.5 kg ha^{-1}, T_4: Boron @ 2.0 kg ha^{-1}, and T_5: Boron @ 2.5 kg ha^{-1}replicated thrice. The variety 'HUW234' was used as a test variety. The seed was applied at the rate of 100 kg ha^{-1}. The RDF

(NPK) was applied @ 120:80:60 kg ha^{-1}. For the analysis of boron concentration 2ml aliquot was taken in a conical flask.1-2 drops of 1N HCl and 10 ml concentrated H_2SO_4 was added to it and after cooling 15 ml 0.05% carmin solution was added to it. After 45 minutes, intensity of color was measured in photoelectric colorimeter at 585 nm wavelength (Gaines & Mitchell, 1979). By comparison with standard graph, final concentration was calculated. The outcome was expressed in mg kg^{-1}. All other agronomic practices were kept uniform for all the plots of the experiment. Observations on yield and yield attributing characteristics parameters were recorded from five selected plants from the net plots. All the data obtained from the experiment were analyzed statistically using the (Gomez & Gomez, 1984), values (P=0.05).

3. RESULTS AND DISCUSSION

Yield is the final result of crop efficiency, shaped by many management approaches. Effective monitoring of production parameters within a specific context yields substantial returns in the form of enhanced output. The data regarding wheat crop yield influenced by varying amounts of B is reported in Table 1 and illustrated in Fig. 1. The Table 1 clearly indicates that the grain yield ranged from 17.03 to 37.70 q ha^{-1}. The highest grain yield of 37.70 q ha^{-1} was achieved with T_4 (2 kg B ha^{-1}), which was statistically comparable to T_5(37.40 q ha^{-1}) with an application of 2.5 kg B ha^{-1}. Nevertheless, the treatment T_0 (no fertilizer delivery) resulted in a markedly low yield of wheat grain. T_4 exhibited a 121.37% increase in grain yield compared to the control (T_0). The % increase of various treatment above control were recorded as with T_1 (92.48%), T_2 (98.76%), T_3 (102.93%), T_4 (121.37%) and T_5 (119.60%). Similar to results of this study differential reaction to B application in wheat crop, several workers have also documented substantial response of B on the grain yield. (Ghatak et al., 2006) reported that application of B @ 15 kg first year and 10 kg ha^{-1} in second year registered in higher values of yield characteristics and yield of wheat crop. Effectiveness of B application @ 2 kg ha^{-1} on the growth and characteristics and eventually yield of wheat crop have also been documented by Saleem et al., (2020); Alharby et al., (2021); Kaleri et al., (2024). As the B level grew simultaneously the straw yield of wheat likewise increased up to application of 2 kg B ha^{-1} with T_4 (47.13 q ha^{-1}). Similar tendency has also been reported in case of total dry matter output of wheat crop. This finding is corroborated by other workers such as Lu et al. (2023); Galindo et al., (2018); Rawashdeh & Sala, (2016). The shoot and root weight was recorded at maximal tillering stage (60 DAS) revealed that dry matter production varied from 0.87 to 1.91 g of shoot and 0.177 to 0.312 g in case of root of wheat crop. Maximum and considerable increased shoot and root weight were recorded with T_4 and T_5 and both were at par. Xiong et al., (2012) observed that 20 micro mol litre 1 of B giving the greatest outcome than greater concentration. Root activity, root length, shoot length, root weight and shoot weight increased initially and then reduced in wheat varieties with varied usage.

Increased the quantity of B application gave rise to an increase in the contents of B in the 3^{rd}leaf. Significantly increased B concentration was found with T_4 (40.63 mg kg^{-1}), which was at par with T_5 (40.47 mg kg^{-1}), while T_0 reported minimal B concentration. A similar observation was reported by Abdel-Motagally & El- Zohri, (2018) in wheat. Ross et al., (2006) conducted

Table 1. Effect of Different level of boron on yield attributing character and yield

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Total dry matter (q ha^{-1})	Dry weight of shoot g^{-3} plant at 60 DAS	Dry weight of root g^{-3} plant at 60 DAS
T_0	17.03	21.29	38.43	0.87	0.177
T_1	32.87	41.08	73.82	1.53	0.238
T_2	33.85	42.32	76.29	1.65	0.262
T_3	34.56	43.20	77.86	1.73	0.282
T_4	37.70	47.13	84.48	1.89	0.318
T_5	37.40	46.75	84.17	1.91	0.312
SEm ±	0.685	0.855	1.475	0.038	0.008
CD	2.186	2.730	4.708	0.122	0.026

Note: T_0= Control (no input), T_1= B @ 0.5 kg ha^{-1}, T_2= B @ 1.0 kg ha^{-1}, T_3= B @ 1.5 kg ha^{-1}, T_4 = B @ 2.0 kg ha^{-1}, T_5= B @ 2.5 kg ha^{-1}

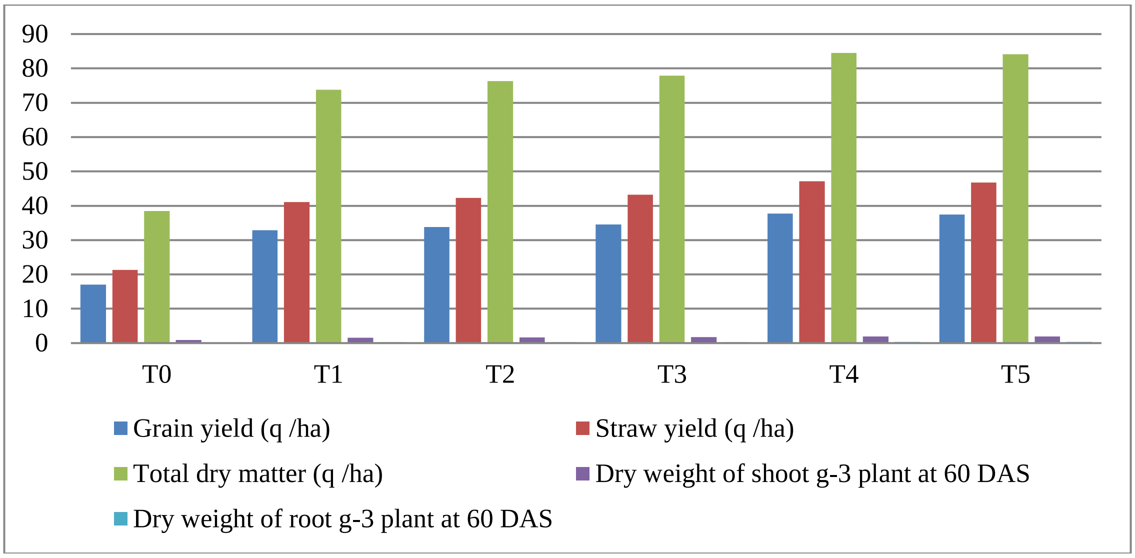

Fig. 1. Effect of Different level of boron on yield attributing character and yield

studies on Soybean, while Hussain et al., (2012) focused on Rice. The mean B concentration in grain is shown in Table 2 and ranged from 11.33 to 25.37 mg kg^{-1} in T_0 to T_5 treatment. Increase in B concentration owing to B application has also been documented by numerous workers, including Abdel-Motagally & El-Zohri (2018); Khalaf et al., (2024); Rodeni et al., (2024). The mean B content in straw (Table 2) ranged between 16 to 37 mg kg^{-1} with T_0 treatment and 30.87 mg kg^{-1} following T_4 (2 kg B ha^{-1}) application.

B levels in root reported at the tillering stage (60 DAS) have been displayed in Table 2 and Fig. 2. The B content in the root varied from 65.20 mg kg^{-1} at 0 level of B (T_0) to 160.20 mg kg^{-1} with T_4 (2 kg B ha^{-1}), which was at par with T_5 (2.5 kg B ha^{-1}). The data indicated that the concentration of B dramatically increased with increasing levels of B application. The results revealed that B content in wheat root was highest, followed by leaf, straw, and least in grain, indicating its poor mobility within the plants. Similar findings were made by Prabhakar (2002).

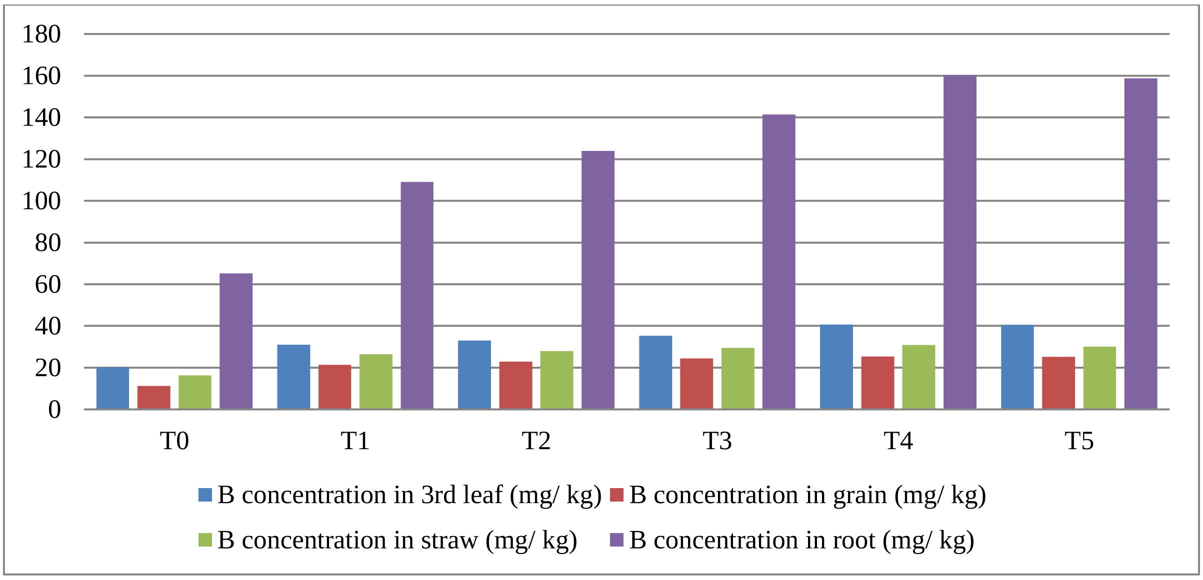

Fig. 2. Effect of Different level of boron on boron concentration

Table 2. Effect of Different level of boron on boron concentration

Treatment	B concentration in 3rd leaf (mg kg^{-1})	B concentration in grain (mg kg^{-1})	Bconcentration in straw (mg kg^{-1})	B concentration in root (mg kg^{-1})
T_0	20.20	11.33	16.37	65.20
T_1	31.03	21.37	26.40	109.00
T_2	33.00	22.87	27.90	124.00
T_3	35.27	24.37	29.53	141.33
T_4	40.63	25.37	30.87	160.20
T_5	40.47	25.17	30.10	158.77
SEm ±	0.87	0.54	0.64	2.67
CD	2.79	1.72	1.97	7.11

Note: T_0= Control (no input), T_1= B @ 0.5 kg ha^{-1}, T_2= B @ 1.0 kg ha^{-1}, T_3= B @ 1.5 kg ha^{-1}, T_4 = B @ 2.0 kg ha^{-1}, T_5= B @ 2.5 kg ha^{-1}

4. CONCLUSION

Based on the present experimental findings, a research study showed that application of boron fertilizer has significant effect on yield (grain yield, straw yield, total dry matter, Dry weight of shoot and Dry weight of root) and the concentration (B concentration in 3rdleaf, B concentration in grain, B concentration in straw and B concentration in root). Boron at the rate of 2.0 kg hac^{-1}could improve the yield parameters and boron concentration in plant parts.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Abdel-Motagally, F. M. F., & El-Zohri, M. (2018). Improvement of wheat yield grown under drought stress by boron foliar application at different growth stages. *Journal of the Saudi Society of Agricultural Sciences*, *17*(2), 178-185.

Alamer, K. H. (2025). Alleviatory Role of Boron Supplementation on the Adverse Effects of Salinity Stress in Wheat. *Journal of Plant Growth Regulation,* https://doi.org/10.1007/s00344-024-11608-0

Alharby, H. F., Nahar, K., Al-Zahrani, H. S., Hakeem, K. R., & Hasanuzzaman, M. (2021). Enhancing salt tolerance in soybean by exogenous boron: intrinsic study of the ascorbate-glutathione and glyoxalase pathways. *Plants (Basel)*, 10(10):2085. https://doi.org/10.3390/plants10102085

Aytop, H., Ates, O., Dengiz, O., Yılmaz, C. H., & Demir, O. F. (2023). Environmental, ecological and health risks of boron in agricultural soils of Amik Plain under Mediterranean conditions. *Stochastic Environmental Research and Risk Assessment*, 37(6), 2069-2081.

Brdar-Jokanovic, M. (2020). Boron toxicity and deficiency in agricultural plants. *International journal of molecular sciences*, 21(4), 1424.

Erenstein, O., Chamberlin, J., & Sonder, K. (2021). Estimating the global number and distribution of maize and wheat farms. *Global Food Security*, *30*, 100558.

Erenstein, O., Jaleta, M., Sonder, K., Mottaleb, K., & Prasanna, B. M. (2022). Global maize production, consumption and trade: Trends and R and D implications. *Food Secur.,* 14 (5), 1295-1319.

Gaines, T. P., & Mitchell, G. A. (1979). Boron determination in plant tissue by the azomethine H method. *Communications in Soil Science and Plant Analysis*, *10*(8), 1099-1108.

Galindo, F. S., Filho, M. C. M. T., Buzetti, S., Rodrigues, W. L., Boleta, E. H. M., Santini, J. M. K., & Azambuja Pereira, M. R. (2018). Effects of Boron (B) doses and forms on boron use efficiency of wheat.

Australian Journal of crop science, *12*(9), 1536-1542.

Ghatak, R, Jana, P. K., Sounda, G., Ghash, R. K., & Bandyopadhyay, P. (2006). Effect of boron on yield, concentration and uptake of N,P and K by wheat grown in farmers field on red and laterite soil of Purulia, W.B. *Indian Agriculture,* 50, 15-77.

Gomez, K. A. & Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. (2ndedn), Wiley-Inter-Science publication, John Wiley and Sons, New York, USA.

Gupta, U., & Solanki, H. (2013). Impact of boron deficiency on plant growth. *International Journal of Bioassays*, 2: 1048-1050.

Hussain, M., Khan, M. A., Khan, M. B., Farooq, M., & Farooq, S. (2012). Boron application improves growth, yield and net economic return of rice. *Rice Science*, *19*(3), 259-262.

Kaleri, A. A., Lund, M. M., Manzoor, D., Uddin, Z., Faizan, M., Azhar, A., Shah, T. H., Solangi, S., Bukhsh, K. K., Rajput, W. A., & Kaleri, G. S. (2024). Comprehensive evaluation of the various effects of fertilization with potassium, zinc, and boron on wheat growth and yield performance. *International Journal of Biology and Biotechnology*, *21*(4), 597-603.

Khalaf, Y. B., Aldahadha, A., Migdadi, O., & Samarah, N. (2024). Boron and magnesium foliar application increase grain yield of durum wheat under drought by improving some physiological parameters. *Agronomy Research*, *22*.

Khalid, A., Hameed, A., & Tahir, M. F. (2023). Wheat quality: A review on chemical composition, nutritional attributes, grain anatomy, types, classification, and function of seed storage proteins in bread making quality. *Front. Nutr*., 10, 1053196.

Kohli, S. K., Kaur, H., Khanna, K., Handa, N., Bhardwaj, R., Rinklebe, J., & Ahmad, P. (2023). Boron in plants: uptake, defciency and biological potential. *Plant Growth Regul.*, 100:267–282. https://doi.org/ 10.1007/s10725-022-00844-7

Li, S., Yan, L., Venuste, M., Xu, F., Shi, L., White, P.J., Wang, X., & Ding, G. (2023). A critical review of plant adaptation to environmental boron stress: uptake, utilization, and interplay with other abiotic and biotic factors. *Chemosphere*, 338:139474. https://doi.org/10. 1016/j.chemosphere.2023.139474

Lu, K., Yan, L., Riaz, M., Babar, S., Hou, J., Zhang, Y., & Jiang, C. (2023). Exogenous boron alleviates salt stress in cotton by maintaining cell wall structure and ion homeostasis. Plant Physiology and Biochemistry, 201:107858. https://doi.org/10.1016/j.plaphy.2023.107858

Manikant, P. (2002). Differential reaction of some wheat genotype to boron stress in calcareous soils. (M.Sc. Thesis). Department of Soil Science *RAU**, Pusa**, Bihar.*

Mengel, K., & Kirkby, E. A. (2001). Principles of Plant Nutrition. (5theds), *Kluwer Academic Publishers*, Dordrecht. Pp 621-638.

Nadeem, F., Farooq, M., Nawaz, A., & Ahmad, R. (2019). Boron improves productivity and profitability of bread wheat under zero and plough tillage on alkaline calcareous soil. *Field Crops Research*, 239, 1-9.

Pereira, G. L., Siqueira, J. A., Batista-Silva, W., Cardoso, F. B., Nunes-Nesi, A., & Araujo, W. L. (2021). Boron: More than an essential element for land plants?. *Frontiers in Plant Science, 11, 610307.*

Prabhakar, B. N., Halepyati, A. S., Desai, B. K., & Pujari, B. T. (2002). Response of wheat genotypes to dates of sowing in north eastern dry zone. *Karnataka Journal of Agricultural Sciences, 15* (4), 688-690.

Rawashdeh, H. M., & Sala, F. (2016). Effect of iron and boron foliar fertilization on yield and yield components of wheat. *Romanian Agricultural Research*, (33).

Rerkasem, B., Jamjod, S., & Pusadee, T. (2020). Productivity limiting impacts of boron deficiency, a review. *Plant and Soil*, 455(1), 23-40.

Rodeni, M. A., Kalhoro, S. A., Lahori, A. H., Kubar, K. A., Mengal, J. A., Mengal, K. H., Raisani, A., Ahmed, S., Kasi, Z. U. A., Ahmed, S., et al. (2024). Application of potassium co-amended with boron for improving the potassium, boron, growth and yield components of wheat under the dry climate condition of Lasbela Balochistan. *Scientific Review Engineering and Environmental Sciences*, 33 (4), 352–371. DOI 10.22630/srees.9875

Ross, J. R., Slaton, N. A., Brye, K. R., & DeLong, R. E. (2006). Boron fertilization influences on soybean yield and leaf and seed boron concentrations. *Agronomy Journal*, *98*(1), 198-205.

Saleem, M. A., Tahir, M., Ahmad, T., & Tahir, M. N. (2020). Foliar application of boron improved the yield and quality of wheat

(Triticum aestivum L.) in a calcareous field. *Soil & Environment*, *39*(1).

Tanaka, M., & Fujiwara, T. (2008). Physiological roles and transport mechanisms of boron: perspectives from plants. *Pflügers Archiv-European Journal of Physiology*, *456*, 671-677.

Warington, K. (1933). The influence of length of day on the response of plants to boron. *Annals of Botany*, 47(187), 429-457.

Woods, W.G. (1994). An introduction to Boron: History, sources and chemistry. *Environmental health perspectives,* 102:5-11.

Xiong, F., Run, Y. U., Zuo, Z., Tong, L., Ling, W. L., Liang, L. D., & Zhong, W. (2012). Effects of boron on seed germination and seedling growth in wheat varieties for different uses. *Journal of Triticeae Crops,* 32, 907-911.

Peer-review history:
The peer review history for this paper can be accessed here:
https://pr.sdiarticle5.com/review-history/130994