Effect of boron on mineral element uptake in cauliflower

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Abstract

Foliar application of boron plays an important role in improving nutrient uptake and mineral balance in cauliflower plants. A field experiment was conducted at the Research Station, Department of Horticulture and Landscape, College of Agriculture, Tikrit University during the 2024–2025 season to evaluate the effect of different boron level and application times on mineral composition and dry matter content. The results showed that foliar application of boron at 100 mg L^{-1} after 75 days from transplanting (DAT) significantly increased leaf dry matter and phosphorus content. Application of 50 mg L^{-1} after 45 DAT significantly enhanced dry matter percentage in flower curds, while the same level after 90 DAT increased leaf nitrogen content (2.36%). In addition, spraying 50 mg L^{-1} after 60 DAT significantly reduced nitrate content in flower curds (0.221%). No significant differences were observed in potassium content, whereas boron concentration in leaves increased significantly with the 50 mg L^{-1} application after 45 DAT.

Keyword: Cauliflower, boron, foliar application dates, dry matter, nitrate

1. Introduction

Cauliflower is one of the main winter vegetable crops and belongs to the family Brassicaceae, which includes more than 350 genera and about 4,000 species distributed worldwide.is considered a biennial plant, and has numerous health benefits due to its content of antioxidants (1;2). In ancient times, cauliflower was used to treat conditions such as gout, stomach problems, and digestive disorders. Its high fiber content contributes to digestive system health and may reduce the risk of chronic diseases due to the presence of indole-3-carbinol. This compound affects estrogen metabolism and may protect against breast cancer and other female-related cancers (3). Cauliflower grows best in cool and humid climates and does not tolerate extremely low temperatures or excessive heat (4). Inadequate and unbalanced nutrition is considered one of the most important factors leading to low cauliflower productivity, as it causes nutrient deficiencies, particularly boron, which is regarded as one of the main factors contributing to soil health deterioration and yield decline Cauliflower is an important winter vegetable with high nutritional value. It contains dietary fiber and antioxidants that help improve digestive health and prevent chronic diseases. It is also a good source of minerals such as calcium, potassium, iron, and magnesium, as well as essential vitamins including vitamin C, vitamin K, and folic acid, making it beneficial for overall health and immunity. (5). Soil application of micronutrients may not always be readily available to plants; therefore, foliar application can be an effective method to overcome nutrient deficiencies. Each micronutrient plays a specific role in plant growth, and its presence at an optimum concentration is essential for completing the plant life cycle, which ultimately contributes to plant protection, meets nutritional requirements, especially micronutrients, and alleviates deficiency symptoms such as leaf

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chlorosis, spotting, related effects 6. Boron plays a pivotal role in cauliflower flowering, fertilization, and seed quality due to the crop's high sensitivity to boron deficiency. Moreover, boron is involved in several physiological processes, including calcium metabolism, auxin synthesis, translocation of soluble substances, and protein synthesis. Enzymatic activities directly responsible for potassium uptake are greatly affected under inadequate boron supply (7). The intensification of agriculture, combined with the use of boron-free inputs and low organic matter, has increased the incidence of boron deficiency in soils. The range between boron deficiency and toxicity is very narrow, requiring precise calibration of boron doses. To correct boron deficiency, two approaches are available: soil and foliar fertilization using several commercial sources such as borax, boric acid (8). Foliar application of boron can correct boron deficiency caused by adverse environmental Because boron in plants is highly sensitive to any external factors that may affect their growth and absorption, also the Boron in plants is sensitive to multiple external factors, including climatic conditions temperature, drought, humidity, soil factors fertility, nutrient availability, pH, and other environmental stresses salinity, diseases, weather fluctuations, all of which affect its uptake and plant.

conditions. Therefore, this study aimed to determine the most effective boron level and the optimal timing of its application to the uptake of mineral elements in cauliflower.

2. Materials and Methods

2.1 Experimental Site

The field experiment was conducted at the Department of Horticulture and Landscape – College of Agriculture – Tikrit University during the 2024–2025 growing season. The experimental site is located at 34.676° N latitude and 43.165° E longitude. The experiment was conducted at the Horticulture Station, College of Agriculture, Tikrit University, Tikrit, Salah Al-Din, Iraq, located between 34.676° N latitude and 43.165° E longitude. The site falls under the sub is located within the hot desert (semi-arid) climatic zone and is characterized during the period from October to February by a mild to relatively cold winter climate .Weather data for the months from October to February were collected from the Iraqi Agricultural Meteorology Center, which is part of the national network of stations. During the experimental period, the average maximum and minimum temperatures were 21.24 °C and 7.54 °C, respectively. No rainfall was recorded during the study period, and an average relative humidity of 53% throughout the study period.

2.2 soil physical and chemical analysis

To determine the physiochemical properties of the soil, a sample was taken for three replicates from different depths of 0-30 cm and a composite soil sample. The soil was then analyzed in the laboratories of the Soil and Water Resources Department at the College of Agriculture, Tikrit University. The pH of the soil was detected with a digital pH meter at 7.9. The total nitrogen, available phosphorus, and potassium were 17.94, 6.25 mg kg^{-1}, and 94.5 mg kg^{-1}, respectively, and were analyzed by using the methods of Kjeldahl distillation (9) and modified (10). The organic matter content of the soil was 0.18 g kg^{-1}, and was determined by (11) titration method. Similarly, soil texture was

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Loamy sand (sand 667, clay 75, and silt 257 g kg^{-1}), and was identified with the hydrometer method (12). The B content was analyzed using the hot water calcium chloride (CaCl2) method (13). The B content in the soil of the experimental plot was not found. Additionally, the values of Fe, Ca^{+2}, Mg^{+2}, Na^{+}, $CaCO_3$, $CaCO_4$, HCO_3^{-}, EC and nitrate were 0.326 mg kg^{-1}, 32meg L^{-1}, 22.7 mmol L^{-1}, 11.45 mg kg^{-1}, 13.4 g kg^{-1}, 5 g kg^{-1},3.08 ds m^{-1} and 35 mg L^{-1} respectively.

2.3. Experimental design and treatment selection

The experiment followed a randomized arrangement in a Randomized Complete Block Design (RCBD) with three replications. The experiment was consisted of nine treatments viz, T0 = Control (no foliar application), T1 = 50 mg L^{-1} at 45 days after transplanting, T2 = 50 mg L^{-1} at 60 DAT, T3 = 50 mg L^{-1} at 75 DAT, T4 = 50 mg L^{-1} at 90 DAT, T5 = 100 mg L^{-1} at 45 DAT, T6 = 100 mg L^{-1} at 60 DAT, T7 = 100 mg L^{-1} at 75 DAT, and T8 = 100 mg L^{-1} at 90 DAT. Boric acid (H_3BO_3 or $B(OH)_3$) containing 17 % B was used as a source of B.

2.4. Cultural operations:

The cauliflower seeds of the variety lce Ball were sown in seedling trays on the 2nd of August. After that, lightly irrigate using a plastic watering can. To prevent the wilting of seedlings, they were watered lightly and regularly. After 60 days, and before field translation, they were hardened for seven days to avoid possible transplanting shock. In the meantime, the transplanting field was prepared by repeated ploughing and harrowing. After that, the field was laid out accordingly. Twenty-seven of the experimental units (2 × 1.40 m). Organic and chemical fertilizers were used according to the recommended quantities. The amount of FYM was 40 tons ha^{-1}, while chemical fertilizer was also used according to recommendation dose 164:80.2:350 kg ha^{-1} NPK, through Urea, Triple Super Phosphate (TSP), and Potash Sulphate (SOP). Both organic and chemical fertilizers were applied two days before transplanting. The organic and chemical fertilizers were applied in a single application, except for the nitrogen fertilizer, which was applied in two applications, 50% before two days of transplanting and the 50% after one month of transplanting (26) Boron was applied as a foliar spray according to the treatment dose in the experiment. Each foliar application was applied three times, with 10 days between each application.

2.5Studied Traits

Measurements were taken at harvest for the flower curds. Five plants were randomly selected from each experimental unit, and the following traits were recorded. The percentage of dry matter in the leaves (%) was determined according to the method described by (14), the percentage of dry matter in the curds (%) was determined following (15), the percentage of total nitrogen in the leaves (%) was estimated according to the method reported by (16), the percentage of total phosphorus in the leaves (%) was determined according to the method of (17), and the percentage of total potassium in the leaves (%) was determined according to (14). Nitrate concentration in the curds (mg kg^{-1}) was determined according to (18), while boron concentration in the leaves (%) was determined according to the method described by (19).

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2.6 Statistical Analysis

The experimental data were analyzed using the SAS(2001) (20).and Mean comparisons were performed according to the Least Significant Difference (L.S.D.) test at a probability level of 0.05.

3.1 Percentage of dry matter in leaves (%)

The results illustrated in Figure (1) indicate a significant effect of foliar application with boron levels and dates on the percentage of dry matter in leaves. Treatment T7 (100 mg L⁻ ¹ 75 DAT) recorded the highest value reached 8.90% but there was not significant difference between it and all other treatments except for T1 and T2. In contrast, treatment T2 recorded the lowest value (8.37%), which in turn did not differ significantly from treatments with T0, T1, T5, and T6.

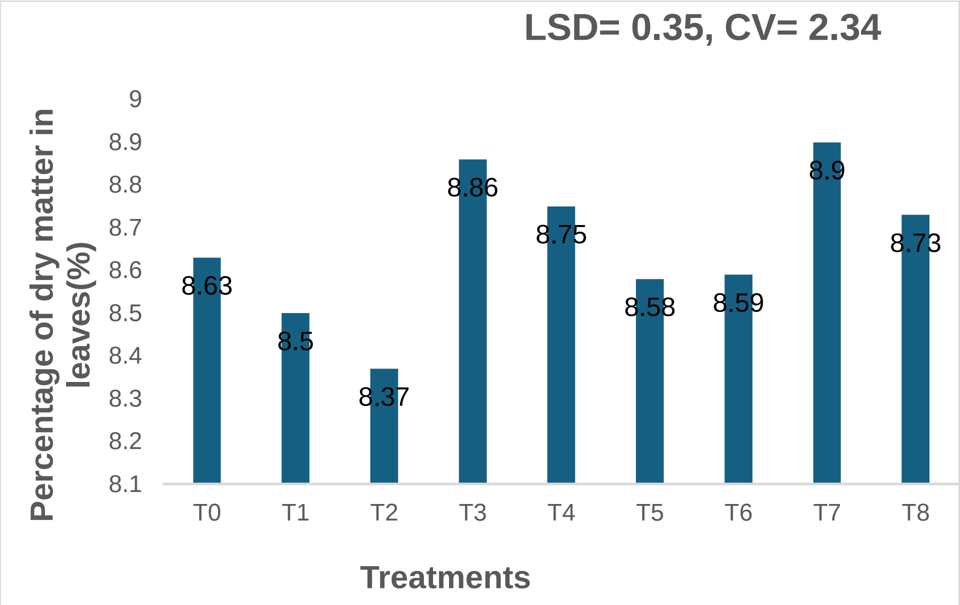

Figure (1). Effect of different levels and dates of foliar application of boron on the percentage of dry matter in leaves (%).

T0 = control, T1 = 50 mg L⁻ ¹ + 45DAT, T2 = 50 mg L⁻ ¹ + 60 DAT, T3 = 50 mg L⁻ ¹ + 75 DAT, T4 = 50 mg L⁻ ¹ + 90 DAT, T5 = 100 mg L⁻ ¹ + 45 DAT, T6 = 100 mg L⁻ ¹ + 60DAT, T7 = 100 mg L⁻ ¹ + 75 DAT, T8 = 100 mg L⁻ ¹ + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.2 Percentage of dry matter in curds flower (%)

Figure (2) significant effect the presence of significant differences among the studied treatments in the percentage of dry matter in flower curds. treatment T4 recorded the highest value amounted to 9.44%, which did not differ significantly from all other treatments except for T0, T1, and T2."other treatments,except for treatment T7 .mean while treatment T1 recorded the lowest value amounted to 8.17%, which did not

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differ significantly from the others except T4 and T7.

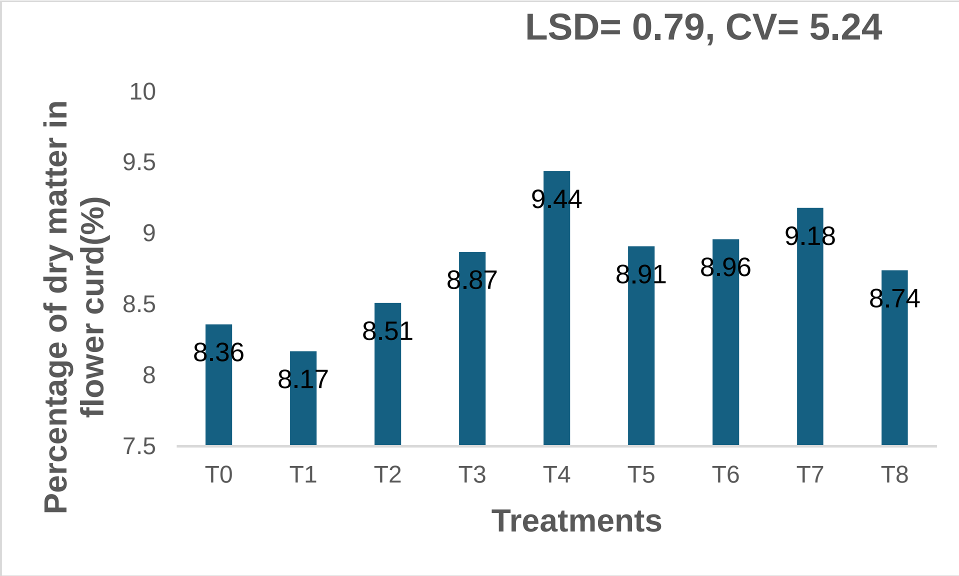

Figure (2). Effect of different levels and dates of foliar application of boron on the percentage of dry matter in flower curds(%).

T0 = control, T1 = 50 mg L^{-1} + 45DAT, T2 = 50 mg L^{-1} + 60 DAT, T3 = 50 mg L^{-1} + 75 DAT, T4 = 50 mg L^{-1} + 90 DAT, T5 = 100 mg L^{-1} + 45 DAT, T6 = 100 mg L^{-1} + 60DAT, T7 = 100 mg L^{-1} + 75 DAT, T8 = 100 mg L^{-1} + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.3 Nitrogen percentage in leaves (%)

The results presented in Figure (3) indicate that treatment T2 increased significantly in nitrogen percentage in leaves (2.36%), without significant differences with treatments T3, T6, and T8. Meanwhile, the control treatment reduced significantly (1.44%), but was not significantly different from treatments T1 and T4, both of which recorded the same value(1.63%).

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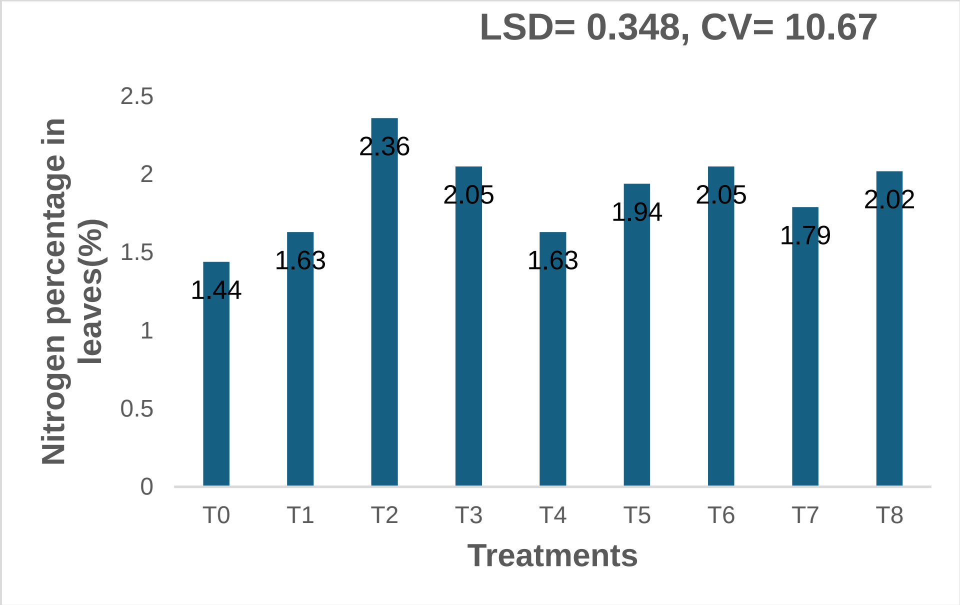

Figure (3). Effect of different levels and dates of foliar application of boron on nitrogen percentage in leaves (%).

T0 = control, T1 = 50 mg L^{-1} + 45DAT, T2 = 50 mg L^{-1} + 60 DAT, T3 = 50 mg L^{-1} + 75 DAT, T4 = 50 mg L^{-1} + 90 DAT, T5 = 100 mg L^{-1} + 45 DAT, T6 = 100 mg L^{-1} + 60DAT, T7 = 100 mg L^{-1} + 75 DAT, T8 = 100 mg L^{-1} + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.4 Phosphorus percentage in leaves (%)

Figure (4) shows clear significant differences among boron levels and application dates in phosphorus percentage in leaves. Treatment T7 gave a significant outperformed in this trait 0.597% compared with other treatments (0.597%), whereas treatment T8 recorded the lowest significant value (0.335%), representing a significant reduction compared to the other treatments.

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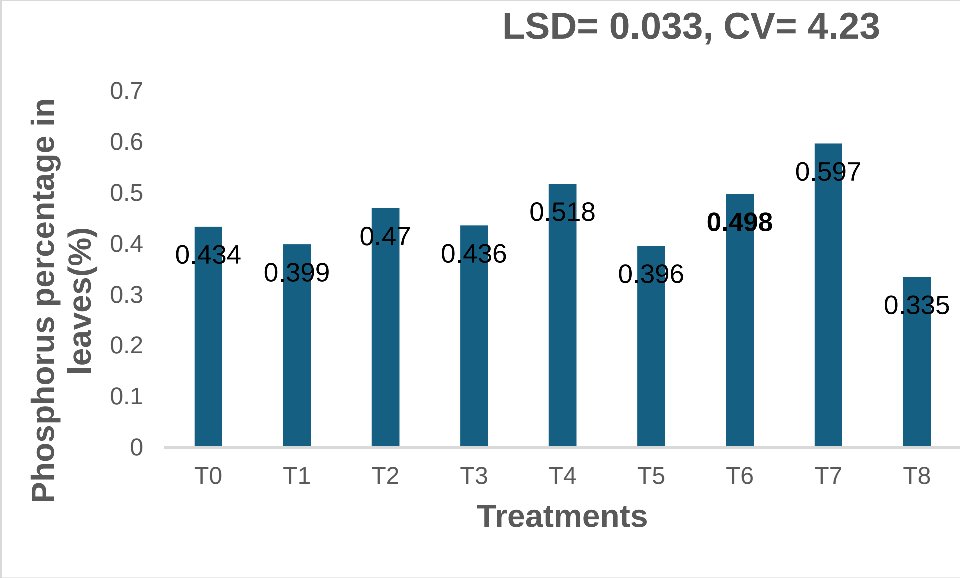

Figure (4). Effect of different levels and dates of foliar application of boron on phosphorus percentage in leaves (%).

T0 = control, T1 = 50 mg L^{-1} + 45DAT, T2 = 50 mg L^{-1} + 60 DAT, T3 = 50 mg L^{-1} + 75 DAT, T4 = 50 mg L^{-1} + 90 DAT, T5 = 100 mg L^{-1} + 45 DAT, T6 = 100 mg L^{-1} + 60DAT, T7 = 100 mg L^{-1} + 75 DAT, T8 = 100 mg L^{-1} + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.5 Potassium percentage in leaves (%)

Figure (5) indicates significant differences among treatments in potassium percentage in leaves. Treatment T1 recorded had the highest value (6.23%), which did not differ significantly from treatments T7,T2 and T5 While treatment T3 was reduced significantly compared to all treatments except T8 as there was no significant difference between them

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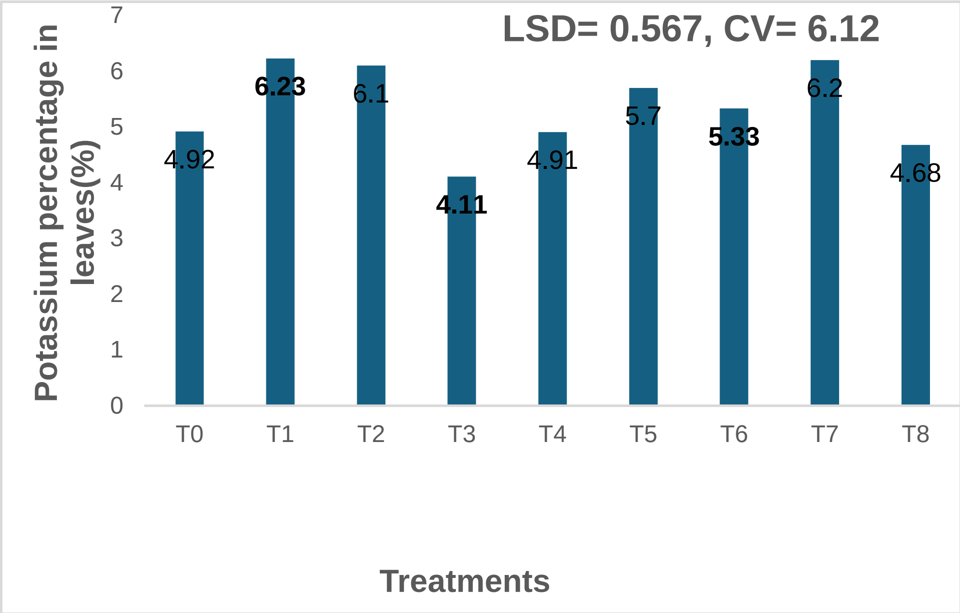

Figure (5). Effect of different levels and dates of foliar application of boron on potassium percentage in leaves (%)

T0 = control, T1 = 50 mg L^{-1} + 45DAT, T2 = 50 mg L^{-1} + 60 DAT, T3 = 50 mg L^{-1} + 75 DAT, T4 = 50 mg L^{-1} + 90 DAT, T5 = 100 mg L^{-1} + 45 DAT, T6 = 100 mg L^{-1} + 60DAT, T7 = 100 mg L^{-1} + 75 DAT, T8 = 100 mg L^{-1} + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.6 Percentage of nitrate in flower curds (%)

The results shown in Figure (6) reveal significant differences among the studied treatments in the percentage of nitrate in flower curds. Treatment T2 gave a significant decrease in the lowest value (0.221%), compared with all other treatments. In contrast, treatment T4 (0.420%), compared to all treatments, increased significantly.

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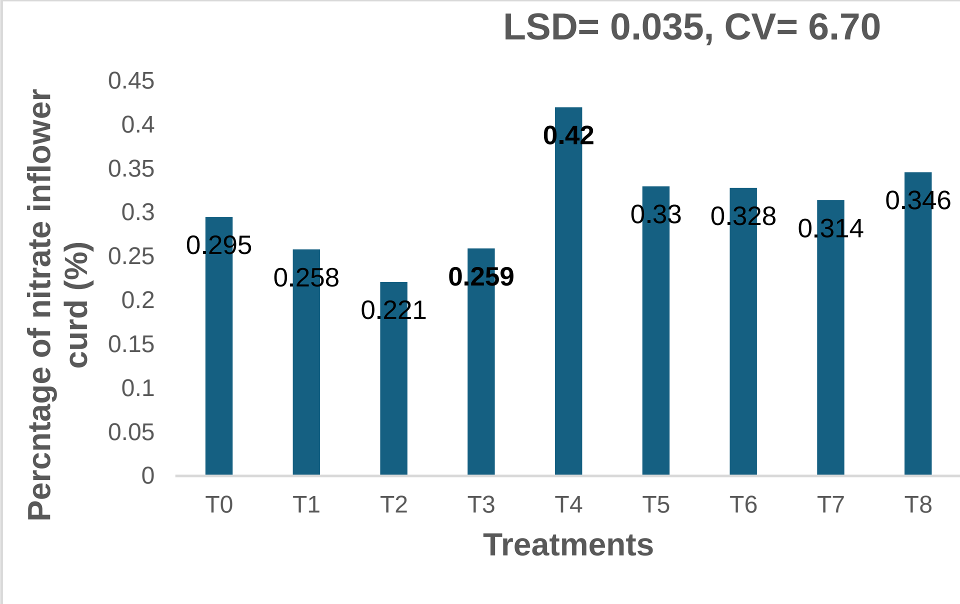

Figure (6). Effect of different levels and dates of foliar application of boron on nitrate concentration in flower curds (%).

T0 = control, T1 = 50 mg L^{-1} + 45DAT, T2 = 50 mg L^{-1} + 60 DAT, T3 = 50 mg L^{-1} + 75 DAT, T4 = 50 mg L^{-1} + 90 DAT, T5 = 100 mg L^{-1} + 45 DAT, T6 = 100 mg L^{-1} + 60DAT, T7 = 100 mg L^{-1} + 75 DAT, T8 = 100 mg L^{-1} + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

3.7 Boron percentage in leaves (%)

The results illustrated in Figure (7) demonstrate significant differences among boron foliar treatments with different levels and application times in their effect on boron percentage in leaves. All foliar application treatments showed a significant increment compared except T0,T5.

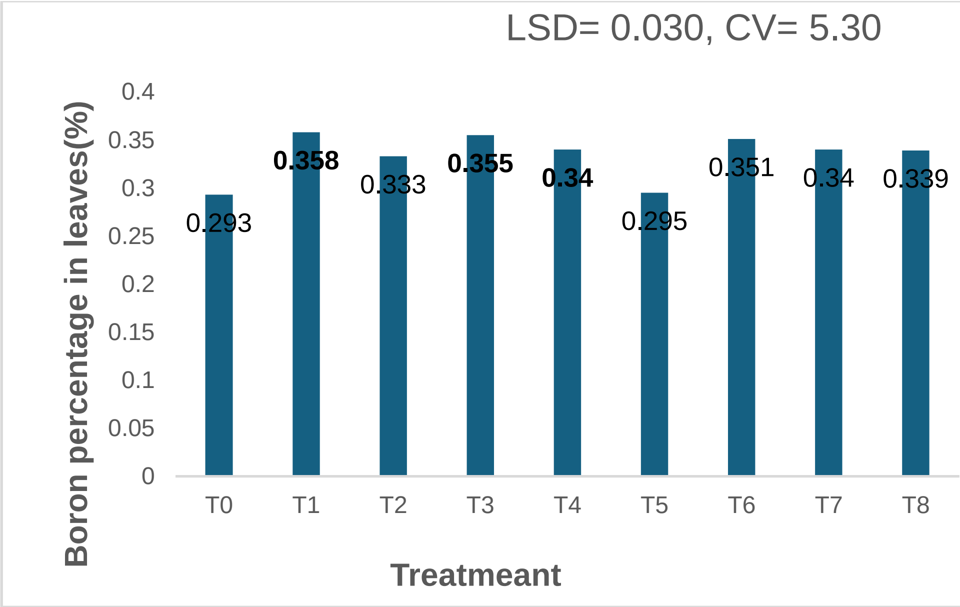

Figure (7). Effect of different levels and dates of application foliar of boron on boron percentage in leaves (%).

T0 = control, T1 = 50 mg L⁻ ¹ + 45DAT, T2 = 50 mg L⁻ ¹ + 60 DAT, T3 = 50 mg L⁻ ¹ + 75 DAT, T4 = 50 mg L⁻ ¹ + 90 DAT, T5 = 100 mg L⁻ ¹ + 45 DAT, T6 = 100 mg L⁻ ¹ + 60DAT, T7 = 100 mg L⁻ ¹ + 75 DAT, T8 = 100 mg L⁻ ¹ + 90 DAT.

L.S.D: Least Significant Difference, CV: Coefficient of Variation.

4. Discussion:

The results indicate that foliar application of boron had a significant effect on the percentage of dry matter in both leaves and the cured; however, the response varied according to boron level and time of application. Leaves recorded the highest dry matter percentage when boron was applied at 100 mg L⁻ ¹ after 75 DAT, which suggests that this date coincides with an active growth phase that enhances the synthesis and translocation of carbohydrates within the leaves. In contrast, the flower cured achieved the highest dry matter percentage when boron was applied at 50 mg L⁻ ¹ after 90 DAT, indicating that flower cured responds better to moderate levels during the late flowering stage. Thus, it becomes clear that the effect of boron depends on the interaction between level and dates, and that each plant organ responds differently, which highlights the importance of considering the physiological stage of the plant when planning foliar application programs (21). The results presented in Figures (3–7) indicate that foliar application of boron caused significant changes in the mineral nutrition of the plant; however, the response varied according to level and dates. Leaf nitrogen percentage increased in treatments corresponding to active growth stages, with T2 (50 mg L⁻ ¹ after 60 DAT) showing the highest value, reflecting the role of boron in enhancing nutrient uptake and stimulating protein synthesis. Phosphorus reached its highest level in treatment T7 (100 mg L⁻ ¹ after 75 DAT), while it decreased in the late high-level treatment T8 (100 mg L⁻ ¹ after 90 DAT), indicating

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that late applications may reduce phosphorus uptake efficiency despite high levels, due to a mismatch with the plant's physiological needs and (22). Potassium content increased in T1 (50 mg L^{-1} after 45 DAT), T7, T2, and T5, and decreased in T3 (50 mg L^{-1} after 75 DAT), highlighting the importance of early to mid-stage applications in improving sugar translocation and stomatal regulation in conjunction with boron's effect on vascular tissues. In the flower curds, nitrate concentration varied, reaching its highest value in T4 (50 mg L^{-1} after 90 DAT, 0.420%) due to slower conversion to protein compounds, while it decreased in more efficient metabolic treatments (T2), (23). The findings agree with those reported by (24) and (22), who emphasized that both application rate and timing are critical factors determining cauliflower response to boron. The appropriate timing (60 DAT) combined with the optimal concentration (50 mg L^{-1}) achieved a balance between growth and productivity, whereas other treatments resulted in partial or weaker responses. The results indicate that foliar application of boron had a significant effect on the percentage of dry matter in both leaves and the floral disc; however, the response varied according to boron concentration and time of application.Boron content in the leaves increased significantly in all foliar treatments compared to the control, with no major differences between level, indicating the plant's ability to regulate boron accumulation and avoid exceeding optimal levels. Overall, these results demonstrate that boron effectiveness depends on the interaction between level and application dates, with applications aligned with sensitive physiological stages providing the best outcomes, whereas increasing the level alone without considering date may be less effective or lead to nutrient imbalance (25).

5. Conclusions

The response of cauliflower to boron clearly depends on both the timing and concentration of application. Early application at a moderate level (50 mg L^{-1} after 45–60 DAT) enhances nitrogen and protein uptake and improves leaf growth. While foliar application after the mid-stage (75 DAT) at a high level (100 mg L^{-1}) increases leaf dry matter and phosphorus, highlighting the importance of this stage for carbohydrate translocation and nutrient accumulation. Late applications (90 DAT) are more effective in improving dry matter and nitrate content in the flowers at a moderate level, whereas high levels after this stage may reduce the efficiency of certain nutrient uptake, such as phosphorus. Each stage of the plant requires appropriate boron data and levels to achieve optimal growth and productivity without causing nutrient imbalanc

References

1. **Boras, M. ; Abu-Turabe, B. ; and Al-Baset, I. (2011)**. Vegetable Crop Production. The Theoretical Part. Damascus University Publication, College of Agriculture, Syria, pp. 466.
2. **Medical News Today (2012).** What are the health benefits of cauliflower MNT Knowledge Center. Medilexicon International Ltd, Bexhill, UK.
3. **Fageria, M. S.; Choudhary, B. R. ; and Dhakha, R. S. (2010).**

Vegetable Crop Production Technology. Kalyani Publishers, India, pp. 80–82.
4. **Sani, M.N.H. ; Tahmina, E. ; Hasan, M.R. ; Islam, M.N. ; and. Uddain, J. (2018).** growth and yield parameters of psyllium in fluenced by oligo-element and plant spacing. Journal of Agriculture and Ecology Research International, 16(1):1-10.
5. **Yadav, H. K. ; Dokra, P. ; and. Yadav, B. (2015).** Effect of nitrogen and zinc foliar application on growth and yield cauliflower (*Brassica oleracea* var. Botrytis L.) Cv. Snowball. Agriculture for Sustainable Development, 2(1): 56–58.
6. **Salmasi, S. ; Behrouznajhad, S. ; and Ghassemi-Golezani, K. (2012).** Effects of foliar application of Fe and Zn on seed yield and mucilage content of psyllium at different stages of maturity. International Conference on Environment, Agriculture and Food Sciences, August 11–12, Phuket, Thailand.
7. **Singh, V. ; Singh, A. K. ; Raghuvanshi, T. R. ; Singh, M. K., Singh, V. ; and Singh, U. (2017).** Influence of boron and molybdenum on growth, yield and quality of cauliflower (*Brassica oleracea L*. var. botrytis). Int. J. Curr. Microbiol. App. Sci., 6(10): 3408–3414.
8. **Dickinson, K. ; and O'Brien, J. (2008).** What are the metalosate products. Plant Nutrition Newsletter, 9(5):1.
9. **Bremmer, J.M. (1965).** Total nitrogen. C.A. Black (Ed.), Methods of Soil Analysis (2 Ed.), American Soc. Agric. Inc., USA (1965), pp. 1149-1178.
10. **Watanabe, F.S. ; and Olsen, S.R. (1965).** Test of an ascorbic acid method for determining phosphorus in water and NaHCO3 extracts from soil. Soil Sci. Soc. Am. J., 29 (6): 677-678.
11. **Walkley, A. ; and Black, I.A. (1934).** An examination of the degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method Soil Sci., 37, 29-38.
12. **Day, P.R. (1965).** Hydrometer method of particle size analysis Methods of Soil Analysis, Black, C.A, American Society of Agronomy, Madison (1965), pp. 562-563
13. **Parker, D.R. ; and Gardner, E.H. (1981).** The determination of hot-water- soluble B in some acid Oregon soils using a modified azomethine- H procedure ommun. Soil Sci. Plant Anal., 12 (12): 1311-1322.
14. **AL-Sahaf, F. H. (1989).** Applied Plant Nutrition. AL-Hikma, University of Baghdad, Ministry of Higher Education and Scientific Research, Iraq.
15. **AOAC (2010)**. Official Methods of Analysis, 13th ed. Association of Official Analytical Chemists, Washington, D.C., USA.
16. **Black, C. A, (1965).** Methods of Soil Analysis Part 2. American Society of Agronic. U.S. A.
17. **Olsen, S. R. ; and Sommers, L. E. (1982).** Phosphorus. In A. L. Page (Ed.), Methods of Soil Analysis, Part 2: Chemical and Microbiological Properties (2nd ed., pp. 403–430).
18. **Strickland, J.D.H. ; and T.R. Parsone. (1972).** Apartical hand book of seawater Anakysis.

Fisheries Research Board of Canada. Bulletin 167.

19. **Carrero, P.; Rojas, E.; Rondon, C.; de Pena, Y. P.; Burguera, J. L. and Burguera, M. (2005).** On-line generation and hydrolysis of methyl borate for the spectrophotometric determination of boron in soil and plants with Azomethine-H. Talanta, 68(2): 374–381.
20. **SAS. (2001). Statistical** Analysis System. SAS Institute Inc. Cary, Nc.USA.
21. **Choudhary, M. ; Singh, R. ; and Yadav, R. (2018).** Role of boron in crop production and sustainable agriculture. International Journal of Chemical Studies, 6(4): 1–4.
22. **Poudel, N., Baral, P. ; Neupane, M. ; Shrestha, S. M. ; Shrestha, A. K., l, N. ; Baral, P., Neupane, M. ; Shrestha, S. M. ; Shrestha, A. K. ; and Bhatta, S. (2022).** Effect of boron on growth and yield parameters of cauliflower (*Brassica oleracea* var. botrytis cv Snow Mystique) in Terhathum, Nepal. International Journal of Applied Sciences and Biotechnology, 10(1):41-49.
23. **FAO (2019).** Nitrate levels in vegetables and their impact on human health. Food and Agriculture Organization of the United Nations. Rome, Italy.
24. **Thakur, D. ; Kumar, P. ; and Shukla, A. K. (2019).** Impact of foliar feeding of boron supplements on growth, yield contributing characters and quality of cauliflower. Biological Forum – International Journal, 11(2):77–82.
25. **Du, W. ; Pan, Z.-Y. ; Hussain, S. B. ; Han, Z.-X. ; Peng, S.-A. ; and Liu, Y.-Z. (2020).** Foliar supplied boron can be transported to roots as a boron-sucrose complex via phloem in citrus trees. Frontiers in Plant Science, 11, 250.
26. **Mohamed, M. H. M.; Petropoulos, S. A.;and Ali, M. M. E. (2021).** The Application of Nitrogen Fertilization and Foliar Spraying with Calcium and Boron Affects Growth Aspects, Chemical Composition, Productivity and Fruit Quality of Strawberry Plants. Horticulturae,7(8), 257.

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