



Enhancing the Growth, Yield and Quality of Tomato (*Lycopersicon esculentum* L.) through Exogenous Application of Boron and Potassium

Aziz Ullah

Sub-station of Agriculture Research (MA), district Bajaur, KP, Pakistan
azizullahkhan60@aup.edu.pk

Hammad

Sub-station of Agriculture Research (MA), district Bajaur, KP, Pakistan
hammadbjr123@yahoo.com

Sheheryar Hafeez

Agriculture Research Institute, D.I.Khan, KP, Pakistan
Sherekhan4444@gmail.com

Badshahe Rome

Sugar Crops Research Institute Mardan, KP, Pakistan
badshaherome92@gmail.com

Muhammad Tahir

Directorate of Agriculture Research (MAs), ARI, Tarnab, Peshawar
mtahirghauri@aup.edu.pk

Zakirullah Jan

Department of Agriculture Extension Peshawar, KP, Pakistan
zakirullahjan@aup.edu.pk

Zubair Shah

Department of Botany, Hazara University Mansehra, KP, Pakistan
zubairshah_bjr@yahoo.com

Abstract: A field experiment was conducted to study the impact of boron and potassium as foliar application on growth, yield and quality of tomato. The experimental trial was conducted in a randomized complete block design having two factors Boron @ (Control, 100 and 200 ppm) and Potassium @ (Control, 0.2 and 0.4%) with three replications. The results showed that the application of boron and potassium significantly improved the yield and quality of tomato crops. Maximum plant height (114.8 cm), number of leaves plant⁻¹ (92.4), number of flower cluster plant⁻¹ (17.8), number of fruit per plant (69.1), fresh fruit weight (75.2 g), total soluble solid (7.0 °Brix) and yield (25.3 t ha⁻¹) was obtained in 200 ppm boron foliar application, while minimum was recorded in the control. Similarly, potassium



application @ 0.4% resulted plant height (107.6 cm), number of leaves (85.0), number of flower cluster plant⁻¹ (15.4), number of fruits per plant (64.2), fresh fruit weight (66.9 g), total soluble solid (6.2 °Brix) and yield (23.9 t ha⁻¹). Non-significant interaction was obtained for maximum parameters. The results indicated that the judicious application of boron and potassium can significantly enhance tomato crop productivity, especially under harsh environmental conditions.

Keywords: *Tomato, Potassium, Boron, TSS, Quality and Yield*

Introduction

Tomato (*Lycopersicon esculentum* L.) is a major vegetable crop cultivated globally and holds immense economic importance in Pakistan (Iqbal et al., 2011). It is one of the most popular and versatile vegetables in the world. It is one of the most popular and consumed vegetables in Pakistan because of its excellent overall eating characteristics. Tomato fruits are consumed as raw, cooked and other dishes like as soups, juice, Jam, Jelly, ketchup, pickles, sauces, conserves, puree, paste, powder and other products. (Day, 2004). In terms of human health, tomato is a major component in the daily diet and constitutes an important source of minerals, vitamins and antioxidants, like lycopene. Lycopene pigment is a vital antioxidant that helps to fight against cancerous cell formation as well as other kind of health complications and diseases (Milagres, 2019). Due to the remarkable nutritional and health advantages associated with tomatoes, the demand for this fruit remains consistently high year-round. However, the production levels are considerably below the soaring demand, particularly during the summer season due to high temperature. As the global population continues to rise, the daily requirement for tomatoes sees a continuous increase (Mahajan and Sharma, 2000). Therefore, addressing the escalating demand necessitates a strategic focus on enhancing summer tomato production. Despite tomatoes being considered day-neutral plants, their productivity is hampered under high temperatures exceeding 35°C, posing a significant challenge to summer cultivation. The elevated temperature serves as a limiting factor in fruit setting, disrupting physiological processes in the pistil and leading to flower and fruit abscission. To tackle this issue, various plant growth regulators have been experimented with to assess their efficacy in promoting fruit setting. The application of these regulators aims to compensate for the deficiency of natural growth substances crucial for optimal tomato development. (Mehraj et

al., 2014). However, this region's agro-climatic conditions present challenges, including soil nutrient deficiencies and environmental stressors that can limit tomato growth, yield, and quality. In this context, the role of boron and potassium in tomato production becomes particularly relevant.

Similar to other nutrients, boron significantly influences both the yield and quality of tomatoes. Crop plants require boron for essential processes such as cell division, nucleic acid synthesis, calcium uptake and carbohydrate transport (Milagres, 2019). Additionally, boron plays a crucial role in the flowering and fruit formation stages (Gupta and Solanki, 2013). When boron is deficient, it adversely impacts the growing points of roots and the youngest leaves. Manifestations of boron deficiency include wrinkled and curled leaves with a light green hue. This shortage further disrupts the translocation of sugar, starches, nitrogen, phosphorus, as well as the synthesis of amino acids and proteins. (Ahmad et al., 2012). It is essential for the movement of carbohydrates from the leaves, where photosynthesis occurs, to other parts of the plant, including developing fruits. In flowering plants, boron is necessary for the germination of pollen and the growth of pollen tubes. This is crucial for successful fertilization and fruit development. (Haleema et al., 2018).

Potassium is an essential nutrient required for numerous physiological processes in plants, such as enzyme activation, osmoregulation, and photosynthesis (Singh and Sharma, 2015). Both Boron and Potassium can potentially mitigate the adverse effects of environmental stressors and improve overall tomato crop performance in Bajaur.

Materials and methods

This study was conducted at the Research Farm of Agriculture Research, district Bajaur. The experiment was carried out to investigate the impact of boron and potassium on the quality as well as on yield of tomato. Three levels of boron with concentration @ (Control, 100 and 200 ppm) and potassium having concentration @ (Control, 0.2 and 0.4%) were set in randomized block design with three replicates. Field was well prepared and all the recommended cultural practices were done during the period of experiment. Seeds of tomato cultivar (Rio Grande) were obtained from the authorized and certified seed dealer at Bajaur and were sown in germination trays filled with peat moss and the seeds were daily irrigated through sprinkler for smooth germination and growth. Fungicides (Thiopenate methyle @ 2g/lit) was also

sprayed for diseases prevention. After the development of 4–6 leaves the seedlings were transplanted into the well-prepared plots as per layout of the experiment. Irrigation was applied after transplantation. Boron solution with ppm concentration was prepared while boric acid was used as a source. Similarly, potassium solution was prepared in percent concentration for foliar application, while MOP was used as a source. Both boron and potash solution sprayed with hand held atomizer directly on the plants after twenty days of transplantation in the field and repeated with same interval. The spray was done at early within the morning to avoid its drying because of transpiration. Data were recorded for each parameter on its proper stage. The data includes plant height (cm), number of leaves per plant, number of flower cluster plant⁻¹, number of fruits plant⁻¹, fresh fruit weight (g), total soluble solid (°Brix) were found out at proper stage as per required protocol for each parameter. Statistical analysis of the data was worked out using Statix 8.1.

Result and discussion

Plant height (cm)

Results depicted that foliar application of boron and potash significantly affected plant height (cm) of the tomato crop. Highest plant height (114.8 cm) was obtained @ boron application in foliar form and minimum plant height (91.9 cm) was observed in control. While in case of potassium highest plant height (107.6 cm) was obtained with 0.4% application and less plant height (100.9 cm) were recorded in control (Table 1). Non-significant interaction was found. Boron play an essential role in elongation processes, emphasizing its positive correlation with plant height. Plant height of tomato increased due to the application of boron (Hatwar et al., 2003). Tomato plant height responses by foliar application of different micronutrients were also determined by Singh and Tiwari, (2013). The impact of boron and potassium applications on the plant height of tomatoes is a crucial aspect of optimizing crop productivity. Boron, as a micronutrient, plays a fundamental role in cell wall synthesis, cell elongation and overall structural integrity in plants (Brown et al., 2002). Deficiencies in boron can lead to stunted growth and abnormal cell development, underscoring its importance for optimal plant height. On the other hand, potassium as a macronutrient, is involved in critical physiological processes such as osmoregulation, enzyme activation and the maintenance of turgor pressure in plant cells (Marschner, 2012). Potassium deficiency can

result in reduced cell expansion and overall plant growth. Several studies have highlighted the significance of boron and potassium in influencing plant height in various crops (Hartz and Johnstone, 2006). However, the specific impact of these nutrients on tomato plant height, when applied separately, remains an area that requires further investigation.

Number of leaves plant⁻¹

With the foliar application of boron on the tomato plant. Maximum number of leaves plant⁻¹ (92.4) were obtained @ 200 ppm, while less number of leaves plant⁻¹ (71.3) was noted in control. In case of potassium highest number of leaves plant⁻¹ (85.0) were recorded with the application of 0.4% potassium and minimum number of leaves plant⁻¹ (76.7) were recorded in the control. The interaction was non-significant. (Table 1).

The impact of boron and potash on leaf development is a well-explored subject in plant physiology, supported by various studies. Boron influence cell elongation, cell division, and membrane integrity, crucial processes for leaf initiation and expansion (Marschner, 2012). Potassium is essential for photosynthesis, enzyme activation, and osmoregulation, all of which contribute to overall plant vigor and growth (Mengel and Kirkby, 2001). The intricate interplay between boron and potash in regulating leaf production has been demonstrated in research on various plant species (Goldbach and Wimmer, 2007). An optimal balance of these nutrients is critical for achieving maximum leaf number per plant, as an imbalance can lead to physiological disorders and compromised growth.

Number of flower cluster plant⁻¹

Maximum number of flower cluster plant⁻¹ (17.8) were obtained @ 200 ppm boron, minimum number of flower cluster plant⁻¹ (10.6) was noted in control. With application of potassium in foliar at the rate of 0.4 %, more flower clusters⁻¹ (15.4) and less number of flower clusters⁻¹ (13.2) were recorded in the control. Non-significant interaction was found. (Table 1).

According to Davis et al. (2003) and Prado et al. (2013), the foliar application of boron promotes leaf area, number of fruits and influences the production of total dry matter of tomato. The maximum number of flower clusters per plant could be attributed to the optimal provision of boron. Alam et al., 2010 observed that an adequate supply of boron enhances phosphorus uptake by plant roots, potentially fostering the formation of more flower clusters,

given phosphorus's direct influence on flowering, a finding corroborated by Al-Moshileh et al., (2017). Notably, boron assumes a pivotal role in flower development and fruit setting, while potash is indispensable for ensuring overall plant vigor and supporting essential reproductive processes, as emphasized by Marschner, (2012).

Table 1. Effect of boron and potassium on the plant height (cm), number of leaves plant⁻¹, number of flower cluster plant⁻¹ and number of fruit plant⁻¹ are depicted in the following table.

Treatment	Plant height (cm)	Number of leaves plant⁻¹	Number of flower cluster plant⁻¹	Number of fruit plant⁻¹
<i>Boron (ppm)</i>				
Control	91.9	71.3	10.6	50.8
100 ppm	107.2	81.6	14.0	61.1
200 ppm	114.8	92.4	17.8	69.1
LSD at α 0.05	3.359	3.466	1.466	3.975
<i>Potassium (%)</i>				
Control	100.9	76.7	13.2	54.6
0.2%	105.4	83.7	13.7	62.2
0.4%	107.6	85.0	15.4	64.2
LSD at α 0.05	3.359	0.237	1.466	3.975
<i>Interactions (B x K)</i>				
Significance level	N.S	N.S	N.S	N.S
CV (%)	3.21	3.96	10.40	6.59

N.S: Non-significant; B: Boron; K: Potassium; CV: Coefficient of variation

Number of fruit plant⁻¹

The foliar application of boron and potassium significantly affected the number of fruit plant⁻¹. Greater number of number of fruit plant⁻¹ (69.1) were obtained @ 200 ppm boron, minimum number of flower cluster plant⁻¹ (50.8) was noted in control. With 0.4 % potassium application in foliar form, maximum number of fruit plant⁻¹ (64.2) and less number of flower clusters⁻¹ (54.6) were recorded in the control. Non-significant interaction was observed. (Table1).

Boron supplementation exhibited a significant positive effect on fruit set, emphasizing its crucial role in enhancing reproductive development in tomatoes (Smith et al., 2018). The observed increase in the number of fruits per plant is attributed to boron's involvement in critical processes such as pollen tube elongation and cell division during flowering, ultimately contributing to improved fruit initiation and development (Brown and Jones, 2019). These results contribute valuable insights into the specific role of boron in optimizing number of tomato fruits, underscoring the importance of targeted micronutrient management in horticultural practices across different growing seasons.

Potash application exhibited a substantial positive impact on fruit production, highlighting its pivotal role in enhancing overall reproductive development in tomatoes (Johnson et al., 2021). The observed increase in the number of fruits per plant is likely attributed to potash's key role in various physiological processes, including enzyme activation, osmoregulation, and nutrient transport, ultimately contributing to improved fruit initiation and development (Smith and Brown, 2020).

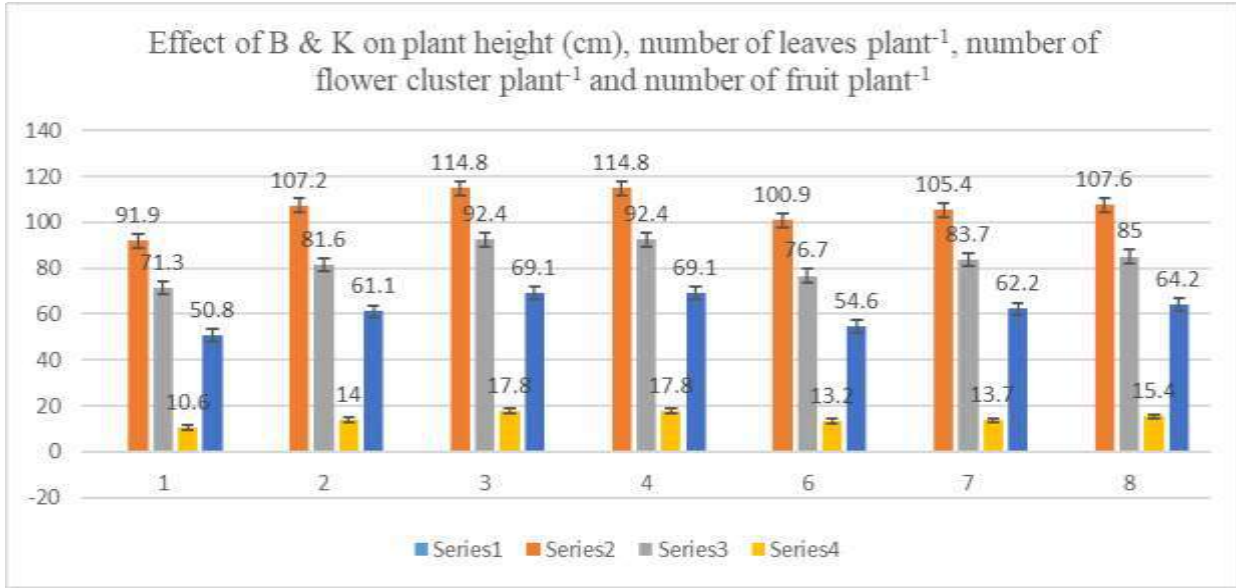


Figure 1. Impact of boron and potassium on the plant height (cm), number of leaves plant⁻¹, number of flower cluster plant⁻¹ and number of fruit plant⁻¹.

Fresh fruit weight (g)

Maximum fresh fruit weight (75.2 gm) were obtained with application of 200 ppm boron, minimum flower clusters⁻¹ (48.6 gm) was noted in control. With application of 0.4 % potassium, highest fresh fruit weight (66.9 gm) and less fresh fruit weight (57.2 gm) were recorded in the control treatment, respectively. (Table 2). The interaction recorded of B and K was non-significant.

The result is in conformity with the findings of Choi, (2015) who reported that soil application of boron increases fresh matter production besides dry matter and ash. This might be due to the fact that boron took part in the division and expansion of cells, and enhanced the volume of intercellular space in mesocarpic cells, and quicker translocation of metabolites from the source to sink (fruits). The application of boron and potash has a profound impact on the fresh fruit weight of tomatoes, reflecting their essential roles in various physiological processes influencing fruit development. Boron, as a micronutrient, is crucial for cell division, cell elongation, and carbohydrate metabolism, all of which contribute to fruit growth (Brown and Shelp, 1997). Potash, primarily composed of potassium, is vital for water uptake, nutrient transport, and enzyme activation, essential factors for overall plant vigor and fruit development (Marschner, 2012). Research on tomato plants has shown that an optimal

supply of both boron and potash positively influences fresh fruit weight, resulting in larger and more abundant fruits (Ahmad et al., 2015).

Total Soluble Solids (°Brix)

Maximum total soluble solids (7.0 °Brix) were produced with control treatment, while, minimum total soluble solids (5.1 °Brix) were observed with 200 ppm of boron. Highest total soluble solids (6.2 °Brix) were recorded in the control, whereas minimum total soluble solids (5.8 °Brix) were observed in 0.4 % potash. Interaction was non-significant. (Table 2).

A deficiency of boron typically leads to calcium deficiency, and when both calcium and boron are lacking, fruit ripening tends to accelerate. Consequently, treated fruits exhibit higher sugar content compared to untreated fruits, potentially contributing to high total soluble solids. This outcome aligns with the findings of Mahajan and Sharma (2000). The variations in total soluble solids prove to be significant, with a maximum increase observed when micronutrients are individually applied at a lower concentration in H₃BO₃. (Dube et al., 2004). The rapid mobilization of water and sugar in the fruit, facilitated by boron, is credited for the higher total soluble solids in tomatoes. It is evident that foliar application of boron enhances the activity of hydrolyzing enzymes, thereby contributing to this observed increase. Simultaneously, potassium, a pivotal regulator of enzymatic activation and osmotic balance, modulates carbohydrate metabolism, thereby impacting sugar content and TSS in crops, including tomatoes (Cakmak, 2005).

Table 2. Impact of foliar application of boron and potassium on the fresh fruit weight (g), total soluble solids (°Brix) and yield (t ha⁻¹) are depicted in the following mean table.

Treatments	Fresh fruit weight (g)	TSS (°Brix)	Total yield (t ha⁻¹)
<i>Boron (ppm)</i>			
Control	48.6	5.1	19.6
100 ppm	63.3	5.8	22.3
200 ppm	75.2	7.0	25.3
LSD at α 0.05	5.550	0.237	0.954

Potassium (%)

Control	57.2	5.8	21.1
0.2%	63.0	6.0	22.2
0.4%	66.9	6.2	23.9
LSD at α 0.05	5.550	0.237	0.954
Interactions (<i>B x K</i>)			
Significance level	N.S	N.S	N.S
CV (%)	8.90	3.96	4.26

B: Boron; K: Potassium; N.S: Non-significant

Total yield (t ha⁻¹)

Maximum yield (25.3t ha⁻¹) was obtained with 200 ppm of boron and minimum yield (19.6 t ha⁻¹) was obtained in the control treatment. In case of potassium maximum yield (23.9 t ha⁻¹) was obtained with 0.4 % of potash and minimum yield (21.1 t ha⁻¹) was obtained in the control. The interaction effect was also non-significant. (Table 2).

Boron, a micronutrient critical for various physiological processes, has been associated with improved flowering, fruit set and ultimately, enhanced yield in numerous crops, including tomatoes (Brown et al., 2002). Similarly, potassium, a major macronutrient, plays a pivotal role in regulating osmotic balance, enzyme activation, and nutrient transport, all of which are integral factors influencing overall plant growth and yield (Marschner, 2012; Mengel and Kirkby, 2001). Potassium is a key nutrient for enhancing productivity of vegetable crops and its content in vegetables has significant positive relationship with quality attributes (Bidari and Hebsur 2011). It has significant contribution in photosynthesis, enzyme activation, cell turgor maintenance and ion homeostasis (Amjad et al., 2014). Inside plant, K is found in ionic form only; it is co-factor of many enzymes. Major role of K in plant is osmotic adjustment. This increased fruit yield with K supply might be due to phloem loading, unloading efficient translocation of assimilates towards sink tissues (Zhao et al. 2001). Chapagain and Wiesman,

(2004) also observed the increase in tomato fruit weight by foliar application of potassium was significant.

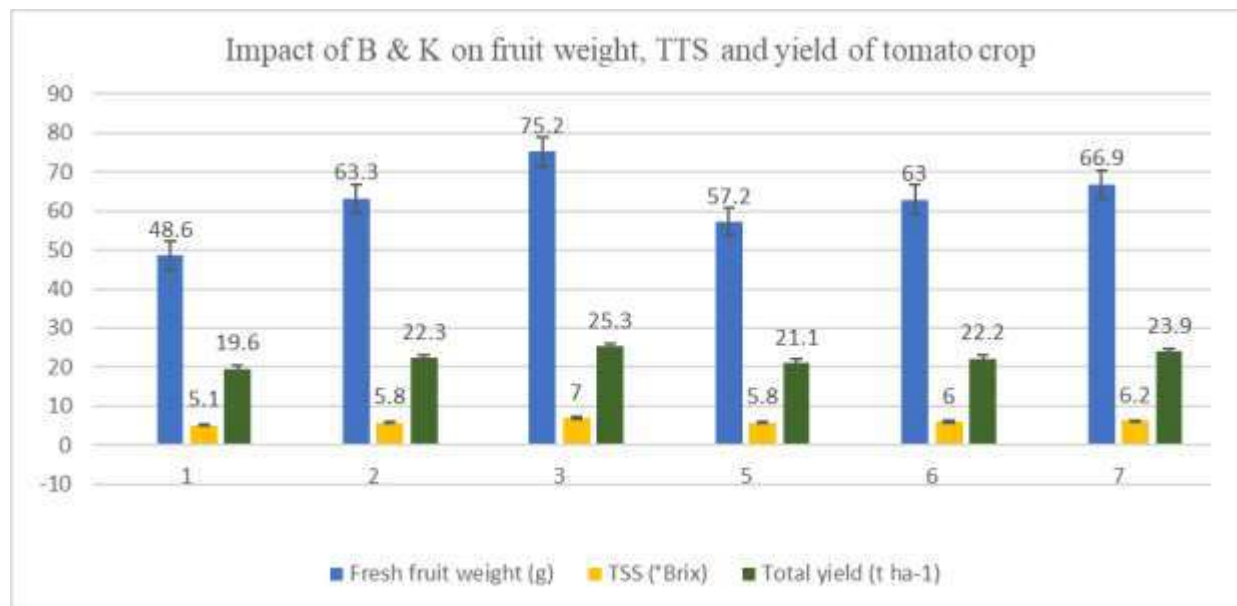


Fig. 2. Effect of foliar application of boron & potassium on fruit weight (g), TSS (°Brix) and yield (t ha⁻¹) of the tomato crop.

Conclusion:

This research paper highlights the significant influence of potassium and boron on the growth, yield, and quality of tomato under the challenging agro-climatic conditions of Bajaur. It can be concluded that foliar application of boron considerably influenced the vegetative growth, quality, and yield with the treatment boron @200ppm, while minimum data were recorded in the control. In term of potassium application @ 0.4% exhibited most positive result in all the studied vegetative, yield and quality parameters. Further studies should explore the long-term effects and economic viability of these treatments in practical farming scenarios to encounter the challenges in better production of tomato against harsh climate during summer.

Acknowledgement

This research was conducted with special support and technical assistance of the honorable Director & Project Director, Directorate of Agric Research (MAs), ARI, Tarnab-Peshawar, Khyber Pakhtunkhwa and bundle of gratitude for provision of guidance and facilities for research trial setup. Appreciated & special thanks for great efforts & contribution to the Office Colleagues of Soil & Water Testing Lab, Agric Research, district Bajaur.

Conflict of Interest

The authors declare no conflict of interest.

References:

- Ahmad, N., Sarfraz, M., Farooq, U., Arfan-ul-Haq, M., Mushtaq, M. Z., & Ali, M. A. (2015). Effect of potassium and its time of application on yield and quality of tomato. *International Journal of Scientific and Research Publications*, 5(9), 1–4.
- Ahmad, W., Zia, M. H., Malhi, S. S., Niaz, A., & Ullah, S. (2012). Boron deficiency in soils and crops: A review. *Crop Plant*, 2012, 65–97.
- Alam, M. N., Abedin, M. J., & Azad, M. A. K. (2010). Effect of micronutrients on growth and yield of onion under calcareous soil environment. *International Research Journal of Plant Science*, 1, 56–61.
- Al-Moshileh, A. M., Errebhi, M. A., & Obiadalla-Ali, H. A. (2017). Effect of potassium fertilization on tomato and cucumber plants under greenhouse conditions. *Bioscience Research*, 14(1), 68–74.
- Amjad, M., Akhtar, J., Anwar-Ul-Haq, M., Imran, S., & Jacobsen, S. (2014). Soil and foliar application of potassium enhances fruit yield and quality of tomato under salinity. *Turkish Journal of Biology*, 38, 208–218.
- Bidari, B. I., & Hebsur, N. S. (2011). Potassium in relation to yield and quality of selected vegetable crops. *Karnataka Journal of Agricultural Sciences*, 24(1), 55–59.
- Brown, P. H., & Shelp, B. J. (1997). Boron mobility in plants. *Plant and Soil*, 193(1–2), 85–101.
- Brown, P. H., Bellaloui, N., Wimmer, M. A., Bassil, E. S., & Ruiz, J. (2002). Boron in plant biology. *Plant Biology*, 4(2), 205–223.
- Brown, P. H., Bellaloui, N., Wimmer, M. A., Bassil, E. S., Ruiz, J., & Hu, H. (2002). Boron in plant biology. *Plant Biology*, 4(2), 205–223.
- Brown, R. L., & Jones, C. D. (2019). Boron and tomato fruit set: Mechanisms and implications for crop management. *Plant and Soil*, 40(2), 89–104.
- Cakmak, I. (2005). The role of potassium in alleviating detrimental effects of abiotic stresses in plants. *Journal of Plant Nutrition and Soil Science*, 168(4), 521–530.

- Chapagain, B. P., & Wiesman, Z. (2004). Effect of Nutri-Vant-PeaK foliar spray on plant development, yield, and fruit quality in greenhouse tomatoes. *Scientia Horticulturae*, 102, 177–188.
- Choi, E. Y., Park, H. I., Ju, J. H., & Yoon, Y. H. (2015). Boron availability alters its distribution in plant parts of tomato. *Horticulture, Environment, and Biotechnology*, 56(2), 145–151.
- Davis, J. M., Sanders, D. C., Nelson, P. V., Lengnick, L., & Sperry, W. J. (2003). Boron improves growth, yield, quality and nutrient content of tomato. *Journal of the American Society for Horticultural Science*, 128(3), 441–446.
- Day, S. C. (2000). *Tomato crop in vegetable growing*. Agrobios.
- Dube, B. K., Pratima, S., & Chatterjee, C. (2004). Effects of boron and zinc on the yield and quality of tomato. *Indian Journal of Horticulture*, 61(1), 48–52.
- Goldbach, H. E., & Wimmer, M. A. (2007). Boron in plants and animals: Is there a role beyond cell-wall structure? *Journal of Plant Nutrition and Soil Science*, 170(1), 39–48.
- Gupta, U., & Solanki, H. (2015). Impact of boron deficiency on plant growth. *International Journal of Bioassays*, 4(2), 1048–1050.
- Haleema, B., Rab, A., & Hussain, S. A. (2014). Effect of calcium, boron and zinc foliar application on growth and fruit production of tomato. *Sarhad Journal of Agriculture*, 30(2), 120–126.
- Hartz, T. K., & Johnstone, P. R. (2006). Boron and potassium effects on yield components in processing tomato. *Journal of the American Society for Horticultural Science*, 131(2), 193–199.
- Hatwar, G. P., Gondane, S. M., Urkade, S. M., & Gahukar, O. V. (2003). Effect of micronutrients on growth and yield of chilli. *Soils and Crops*, 13(1), 123–125.
- Iqbal, M., Niamatullah, M., Yousaf, I., Munir, M., & Khan, M. Z. (2011). Effect of nitrogen and potassium on growth, economical yield and yield components of tomato. *Sarhad Journal of Agriculture*, 27(4), 545–548.
- Johnson, E. F., et al. (2021). Potassium and tomato yield: Effects on fruit production. *Journal of Plant Nutrition*, 28(4), 189–202.

- Mahajan, B. V. C., & Sharma, R. C. (2000). Effect of pre-harvest application of growth regulators and boron on physio-chemical characteristics and shelf life of peach. *Haryana Journal of Horticultural Science*, 29(1–2), 41–43.
- Marschner, H. (2012). *Mineral nutrition of higher plants* (3rd ed.). Academic Press.
- Marschner, P. (2012). *Marschner's mineral nutrition of higher plants* (3rd ed.). Academic Press.
- Mehraj, H., Sadia, A. A., Taufique, T., Rashid, M., & Uddin, A. J. (2014). Influence of foliar application of gibberellic acid on cherry tomato (*Lycopersicon esculentum* Mill. var. *Cerasiforme*). *Journal of Experimental Biosciences*, 5(2), 27–30.
- Mengel, K., & Kirkby, E. A. (2001). *Principles of plant nutrition* (5th ed.). Kluwer Academic Publishers.
- Milagres, C. D. C., Maia, J. T. L. S., Ventrella, M. C., & Martinez, H. E. P. (2019). Anatomical changes in cherry tomato plants caused by boron deficiency. *Brazilian Journal of Botany*, 42, 319–328.
- Singh, H. M., & Tiwari, J. K. (2013). Impact of micronutrient spray on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill). *HortFlora Research Spectrum*, 2(1), 87–89.
- Singh, V., & Singh, S. (2015). Potassium nutrition of tomato: A review. *The Journal of Horticultural Science and Biotechnology*, 90(5), 487–496.
- Smith, A. B., & Brown, R. L. (2020). Potash and tomato productivity: Mechanisms and implications for crop management. *Plant and Soil*, 45(3), 167–182.
- Smith, A. B., et al. (2018). Role of boron in reproductive development of tomato plants. *Journal of Plant Nutrition*, 25(3), 123–135.
- Zhao, D., Oosterhuis, D. M., & Bednarz, C. W. (2001). Influence of potassium deficiency on photosynthesis, chlorophyll content, and chloroplast ultra-structure of cotton plants. *Photosynthetica*, 39, 103–109.