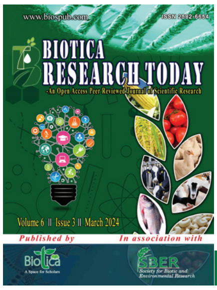

Bio. Res. Today 2024, 6(3):100-103

Biotica Research Today

e-ISSN: 2582-6654

March, 2024

Article ID: RT1583 Popular Article

Role of Boron in Plant Nutrition - Deficiency and Corrective Measures

V. Prasad[1*] and M. Bhargava Narasimha Yadav[2]

[1]*Dept. of Soil Science and Agricultural Chemistry, Professor Jayashankar Telangana State Agricultural University, Rajendra Nagar, Hyderabad, Telangana (500 030), India*

[2]*Dept. of Soil Science and Agricultural Chemistry, College of Agriculture-Dharwad, University of Agricultural Sciences, Dharwad, Karnataka (580 005), India*

Open Access

Corresponding Author

V. Prasad

: vavillaprasad7228@gmail.com

Conflict of interests: The author has declared that no conflict of interest exists.

How to cite this article?

Prasad and Yadav, 2024. Role of Boron in Plant Nutrition - Deficiency and Corrective Measures. *Biotica Research Today* 6(3), 100-103.

Abstract

An important micronutrient for many facets of plant development and metabolism is boron. Its roles encompass crucial functions such as cell wall formation, sugar transport, regulation of enzyme activities involved in nitrogen assimilation and amino acid metabolism, conversion of starch to sugars, modulation of plant hormones like auxins and facilitation of reproductive processes including seed setting and fruit development. By participating in these fundamental processes, boron ensures proper plant development, improves fruit quality and enhances overall yield. Boron deficiency in plants can lead to reduced shoot and root growth, reproductive failure, susceptibility to stress resulted in decrease the crop yield.

Keywords: Boron, Corrective measures, Deficiency, Micronutrient

Introduction

Plant growth and development depend on nutrient components, driving various physiological and biochemical processes within them. Boron (B) stands out for its intriguing and diverse chemistry, making it a fascinating element. In contrast to carbon, boron is never found in nature in its basic form. It belongs to group III of metalloids, exhibiting properties that lie between metals and non-metals (Warington, 1923). In the lithosphere and hydrosphere, boron is extensively distributed despite its low concentration. The average range of boron concentrations in rocks is 5 to 10 mg kg^{-1}, but the range in rivers is 3 to 30 µg L^{-1}. Oceans contain around 4.5 mg L^{-1} of boron.

The main form of boron in rocks and sediments is borate, which is frequently found hydrated and coupled with oxygen, sodium, calcium, silicon or magnesium. Over 200 minerals have been found to contain boron; some of the more notable ones include tourmaline, borax (sodium borate hydrate), colemanite (calcium hydroxide hydrated hydroxide), ulexite (sodium hydroxide, hydrated calcium) and kernite (an additional type of sodium borate hydrate). But most of the boron in these minerals is not easily absorbed by plants.

Its mobility within the soil makes it susceptible to movement. Given its requirement in small quantities, ensuring even distribution of boron across the field is paramount. Traditional fertilizer blends containing boron often face challenges in achieving uniform nutrient spread.

Major Functions of Boron in Plants Growth

- Boron contributes to the synthesis of cell wall components, specifically pectin that offers structural support to plant cell walls. Enough boron is needed to produce strong cell walls, which allow cells to proliferate and aid in the development of the plant as a whole.
- In legume crops, enough boron levels are required for effective nitrogen fixation and nodulation.

Article History

RECEIVED on 07th March 2024 RECEIVED in revised form 20th March 2024 ACCEPTED in final form 21st March 2024

• The development of pollen tubes and germination are aided by boron; thereby aiding the crucial processes of pollination and fertilization in flowering plants. Its role includes promoting the growth and elongation of pollen tubes, enabling them to reach the ovules for successful fertilization.

• Boron is indispensable for the maturation of seeds and fruits. It is essential for controlling cell division and differentiation throughout the growth of seeds and fruits; thereby enhancing seed viability and fruit set. Insufficient boron levels may result in irregular seed growth and diminished fruit quality.

• Boron participates in the movement of sugars within plants, impacting the function of enzymes engaged in sugar metabolism and transport. This influence extends to carbohydrate distribution and allocation within the plant, which is especially critical during periods of rapid growth and reproductive stages.

• Boron interacts with various nutrients like calcium, magnesium and potassium, influencing their absorption and utilization by plants. By facilitating the efficient uptake and translocation of these nutrients, boron contributes significantly to the overall nutrition and health of the plant.

• Boron contributes to maintaining water balance within plants by regulating the movement of water and nutrients across cell membranes. It plays a crucial role in controlling osmotic processes and facilitating water uptake. Optimal boron levels are essential for ensuring proper water relations, enabling plants to withstand drought stress more effectively.

• Boron has been associated with enhancing a plant's resilience against both biotic and abiotic stresses. It boosts the plant's defence mechanisms against pathogens and pests, while also increasing tolerance to environmental challenges like high temperatures and nutrient imbalances.

Plants with boron concentrations ranging from 5 to 30 ppm are considered potentially deficient in boron. For gramineous plants, the critical shortage range for boron is 5 to 10 ppm, whereas for dicotyledons, it is 20 to 70 ppm. Where as in soils contain less than 0.7 ppm of boron is considered as deficient and recommended for corrective measures. The terminal buds or the youngest leaves show the most obvious signs of a severe lack of boron; they get discoloured and may even die.

Deficiency Symptoms of Boron in Plants

A lack of boron frequently causes fewer blooms per plant, empty pollen grains and low pollen vitality. Low B supply has also been proven to inhibit root development in canola and soybean. Stunted development and meristematic growth point death are typical in cases of severe B insufficiency. Reduced root elongation, blooms that are unable to lay seeds and fruit abortion are other frequent effects. In addition to negatively affecting pollination and seed set, low B supply may also occur without obvious signs of leaf shortage.

B Deficiency in Different Crops

Heart Rot of Sugar Beet

Boron deficiency in sugar beets typically leads to the demise of the growing point and the onset of black heart rot. Prior to reaching this critical stage, affected leaves may exhibit cracked petioles and gradually diminish in size, displaying some deformities. Following the demise of the growing point, new leaf clusters emerge in older leaf axils, while the crown becomes susceptible to hollowness and decay (Figure 1). The best method for maximizing sugar beetroot output (104 t ha^{-1}) and juice quality appears to be foliar spraying 150 ppm boron three times at 40, 65 and 90 days after the plant emerges (Bithy *et al*., 2020).

Figure 1: Heart rot of sugar beet

Browning or Hollow Stem of Cauliflower

On plants, this symptom appears on the outside after curd development. First, patches of wetness appear on the stem and curd surface. When the plant ages, its stem hollows out, revealing walls of an interior hole lined with tissues drenched in water (Figure 2). When the condition reaches advanced stages of shortage, the surface of the curd develops brown or pink coloured spots, which are called brown rot, red rot, or curd browning. Both of the boron levels seem to have an impact on the prevalence of hollow stem. With soil application, hollow stem occurrences were shown to be lower at boron concentrations of 2 and 4 kg ha^{-1} (57.1% and 42.9%, respectively) (da Penha Ribeiro *et al*., 2017).

The effective correction of these deficiencies can be achieved by administering borax. The type, pH and degree of the deficiency of the soil all affect how much borax is required. Generally, 10-15 kg $acre^{-1}$ of borax is sufficient for acidic soils. Larger amounts, however, could be required for alkaline and neutral soils.

Figure 2: Hollow stem of cauliflower

Top Sickness of Tobacco

Tobacco plants exhibit early stunted growth compared to their healthy counterparts. Initial signs include noticeable distortion at the growing point, with the youngest leaves displaying kinks and irregular growth patterns (Figure 3). Furthermore, the upper leaves become thick and brittle to the touch, imparting a distinct "ridged" sensation compared to healthy plants. Potassium fertilizer @ 420 kg ha^{-1} application in soil with high boron content has been shown to mitigate the toxic effects of boron on tobacco cultivation resulted significant improvements in net photosynthetic rate, SPAD value, peroxidase (POD) activity and dry matter content (Tan *et al.*, 2017).

Figure 3: Top sickness of tobacco

Internal Cork of Apple

These symptoms typically manifest around 6-8 weeks after fruit formation and are only observable upon cutting the fruit, not visible on the external surface. Circular marks emerge on the flesh, followed by the drying up of spots. The colour of the spots darkens from the centre outward. Spongy lesions develop and cavities may form in the core region. Additionally, brown tissue predominantly forms in the core region (Figure 4). Typically, an apple orchard's annual demand for leaf and fruit growth necessitates approximately 396.89 g of borax $acre^{-1}$. Applying 0.5 to 1 pound of hydrated borax $tree^{-1}$, or 50 to 100 pounds $acre^{-1}$, broadcasted, has been found to be both safe and effective in providing satisfactory control of internal cork (Askew and Chittenden, 1936).

Figure 4: Internal cork of apple

Corrective Measures for Boron Deficiency

To fully comprehend the nitrogen levels in your farm, do soil tests every two years. A soil fertility specialist can help you evaluate your production goals with the present demands for nutrients and explore your possibilities. It is crucial to select the appropriate source and administer the appropriate amount of B at the appropriate pace since there is a thin line separating toxicity and deficiency. For salty soil and where foliar application is recommended. For humid and heavy soil dosage of 10-14 kg $acre^{-1}$ and in light soils @ of 7-10 kg $acre^{-1}$ should be applied. Aspire incorporates boron and potassium into each granule using Nutriform® technology to provide balanced crop nutrition. Some of fertilizers containing fertilizers mentioned below.

a) Foliar application of Borax ($Na_2B_4O_7 \cdot 10H_2O$) (10.6% B) @ 0.1% concentration.

b) Because of its delayed solubility, calmonite ($Ca_2B_4O_7 \cdot 5H_2O$) is a good fit for sandy soils.

c) Boric acid (H_3BO_3) (17% B).

d) Solubor ($Na_2B_40_7 \cdot 5H_2O + Na_2B_{10}O_6 \cdot 10H_2O$) contains 20-2%.

Conclusion

One micronutrient that is essential to agricultural plant growth and development is boron (B). Despite its critical importance, boron deficiency ranks as the second most widespread micronutrient deficiency issue globally, following zinc. Despite its small requirement, boron fulfils several vital roles in plant physiology.

References

Askew, H.O., Chittenden, E., 1936. The use of borax in the control of 'Internal Cork' of Apples. *Journal of Pomology and Horticultural Science* 14(3), 227-245.

DOI: https://doi.org/10.1080/03683621.1937.11513473.

Bithy, S., Paul, S.K., Kader, M.A., Sarkar, S.K., Mahapatra, C.K., Islam, A.K.M.R., Sarkar, M.A.R., 2020. Foliar Application of Boron Boosts the Performance of Tropical Sugar Beet. *Journal of Bangladesh Agricultural University* 18(3): 537-544. DOI: https://doi.org/10.5455/JBAU.121026

da Penha Ribeiro, L.M., Zanuzo, M.R., Vieira, C.V., Junior, S.S., Júnior, F.F., 2017. Cauliflower quality and yield under tropical conditions are influenced by boron fertilization. *African Journal of Agricultural Research* 12(12), 1045-1053. DOI: https://doi.org/10.5897/AJAR2016.11885.

Tan, X., Yang, H., Xu, Z., Lin, Y., Xiong, Q., Wang, G., Bai, Y., Lyu, S., Cheng, Y., Zhu, X., 2017. Effects of high-boron soil planting tobacco on growth of fluecured tobacco and potassium fertilizer regulation measures. *Journal of Southern Agriculture* 48(10), 1789-1794. DOI: https://www.cabidigitallibrary.org/doi/full/10.5555/20183035540

Warington, K., 1923. The effect of boric acid and borax on the broad bean and certain other plants. *Annals of Botany* 37(148), 629-672. URL: https://www.jstor.org/stable/43236455.