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Boron – Importance in Plant Growth

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Boron is the second most common micronutrient deficiency problem globally after zinc, despite the need for this essential nutrient. All crops require boron (B) for healthy growth. It is a part of the reproductive and cell walls of plants. It is a soil nutrient that is capable of moving around because it is mobile. B must be distributed across the field as evenly as possible because it is needed in small quantities. B-containing conventional fertilizer blends have trouble distributing nutrients evenly. Boron is essential for a wide range of plant processes, including pollination and seed set as well as the formation and stability of cell walls and the maintenance of the structural and functional integrity of biological membranes. Effective nitrogen fixation and nodulation in legume crops also depend on adequate B levels. B affects the soil's other plant nutrients' ability to be absorbed and available. It enhances P, N, K, Zn, Fe, and Cu uptake and translocation in cotton leaves, buds, and seeds (Ahmed *et al.*, 2011). Empty pollen grains, poor pollen vitality, and fewer flowers per plant are typical effects of boron deficiency. Root growth may also be hampered by low B supplies. The majority of crops are unable to transfer B from vegetative tissues to meristematic plant tissues that are actively growing, such as shoots, root tips, flowers, seeds, or fruits. Instead, B transport is primarily a result of transpiration and happens in the xylem channel. As a result, deficiencies first manifest in newly formed plant tissue like young leaves and reproductive organs. Some of the most severe disorders caused by boron deficiency include brown-heart of rutabaga (*Brassica napobrassica* L. *Mill*), and internal brown-spot of sweet potatoes (*Iponoea batatas* L. *Lam*) (Akbas *et al.*, 2009). In the present article, the importance of B in plant nutrition, mechanisms of absorption and transfer of B in plant, interaction of B with other nutrients, B deficiency and toxicity in plant is discussed.

Importance of Boron in Plant Nutrition

- Boron is a micronutrient that plays a vital role in the growth and development of plants. It is an essential element that helps in the functioning of various physiological and biochemical processes of plants. Boron is required in small amounts, but its importance cannot be overlooked in plant nutrition. In this article, we will discuss the importance of boron in plant nutrition.
- It is necessary for the maintenance of cell walls, the transport of sugar and carbohydrates, and the development of reproductive structures such as flowers and seeds. It is also required for the proper functioning of the meristem tissues responsible for the growth of new plant tissues. Boron is essential for the synthesis of nucleic acids and proteins, the metabolism of calcium, and the regulation of plant hormones.
- One of the most crucial functions of boron in plants is the maintenance of the cell wall structure. Boron helps to cross-link pectin molecules in the cell wall, thereby providing

structural support to the plant cells. Without boron, the cell walls become weak, and the plants become susceptible to damage and disease.

- Boron also plays a role in the movement of sugars and carbohydrates within the plant. It helps to transport sugar from the leaves to the rest of the plant, providing the energy required for growth and development. Additionally, boron is involved in the synthesis of the hormone auxin, which regulates the growth and development of plants.
- Another important role of boron in plant nutrition is in the development of reproductive structures such as flowers and seeds. Boron deficiency can result in the failure of flowers to open, the production of fewer seeds, and the deformation of fruits and vegetables.
- It is also required for the proper functioning of meristem tissues, which are responsible for the growth of new plant tissues. Boron deficiency can cause the meristem tissues to become disorganized, resulting in stunted growth and the production of fewer leaves and stems.
- It is essential for the metabolism of calcium in plants. It helps to transport calcium to the growing tips of the plant, where it is needed for cell division and expansion. Without boron, calcium cannot be transported to the growing tips, resulting in stunted growth and reduced yield.

Mechanisms of absorption and transfer of B in plant

Boron is absorbed by plants through its roots as boric acid (H_3BO_3) or borate ions (BO_3^{3-}) from soil solution. The uptake of boron is an active process that requires energy in the form of ATP. Once absorbed, boron is transported within the plant by the transpiration stream, and its movement is unidirectional.

There are two mechanisms of boron transport in plants: apoplastic and symplastic transport.

1. **Apoplastic Transport:** In this mechanism, boron moves through the cell walls and intercellular spaces of the plant's tissue. It is then taken up by the endodermis, where it enters the symplast. The apoplastic transport of boron is driven by the water movement in the transpiration stream.
2. **Symplastic Transport:** In this mechanism, boron moves through the cytoplasm of the plant cells. It is taken up by the plasma membrane of root cells and then moves through the plasmodesmata, which are channels that connect the cytoplasm of adjacent cells. Symplastic transport is driven by the concentration gradient of boron and facilitated by transport proteins.

Once absorbed, boron is transported to the shoot system of the plant, where it is used for various physiological and biochemical processes. The movement of boron within the plant is regulated by a number of factors, including the concentration of boron in the soil solution, the pH of the soil, and the stage of plant growth.

Deficiency Symptoms

Boron deficiency symptoms become conspicuous on the terminal buds or the youngest leaves, which become discoloured and may die under acute conditions of B-deficiency.

1. Internal cork of apple
2. Uneven thickness peel, gummy deposits and lumpy fruit in citrus
3. Brown heart in root crops
4. Heart rot of sugar beet
5. Heart rot of mangold
6. Browning or hollow stem of cauliflower
7. Top sickness of tobacco
8. Cracked stem of celery (Increased diameter of stem and petioles)
9. Fruit cracking
10. Crown rot of sugar beet

11. Hard fruits
12. Hen and chicken disease in grapes
13. Brown heart of radish
14. Crown chocking of coconut
15. Rotting of fruit

Symptoms of Boron Toxicity

1. Reduced plant growth and vigor
2. Chlorosis or yellowing of the leaves, especially at the tips
3. Necrosis or death of leaf tips and margins
4. Thickening and deformation of leaves and stems
5. Reduced fertility and seed production
6. Excessive branching and shoot proliferation
7. Accumulation of anthocyanin pigments, resulting in red or purple leaves or stems
8. Reduced water uptake and plant wilting
9. Reduction in the uptake of other nutrients such as calcium and magnesium.

Conclusion

In conclusion, boron is an essential micronutrient for plant growth and development, and its importance cannot be overstated. It plays a vital role in several physiological and biochemical processes, including cell wall formation, pollen tube growth, and sugar transport. Boron deficiency can lead to stunted growth, reduced fertility, and deformation of plant tissues, while toxicity can cause chlorosis, necrosis, and reduced water uptake. It is crucial to maintain an adequate supply of boron in the soil for optimal plant growth and productivity. However, the amount of boron required by plants varies widely depending on the plant species, soil pH, and other environmental factors. It is recommended to conduct soil tests and adjust boron levels accordingly to prevent deficiencies or toxicity. Overall, it is an essential nutrient that is vital for plant growth and plays a crucial role in ensuring food security and sustainable agriculture.

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