Impact of Boron in Plant Growth and Development

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ABSTRACT

Boron (B) is vital to plant health, due to its role in forming and strengthening cell walls. B is a unique non-metal essential microelement for plants and constantly needed throughout plants life for normal growth and development. B requirements are much higher for reproductive growth so it helps with pollination and fruit and seed development. Low boron levels lead to poor growth of fast growing tissues and plant development. Different plants need different amounts of boron, but for the most part, boron is not easily transported within the plants. The effects of insufficient B supply on various physical and growth parameters of plant can lead to plant death.

INTRODUCTION

Boron is a micronutrient critical to the growth and health of all crops. Boron is an essential trace element required for the physiological functioning of higher plants. Boron deficiency is considered as a nutritional disorder that adversely affects the metabolism and growth of plants. Boron is involved in the structural and functional integrity of the cell wall and membranes, ion fluxes across the membranes, cell division and elongation, nitrogen and carbohydrate metabolism, sugar transport, cytoskeletal proteins, and plasmalemma-bound enzymes, nucleic acid, indoleacetic acid, polyamines, ascorbic acid, and phenol metabolism, reproductive structures and transport. It is a mobile nutrient within the soil, meaning it is prone to movement within the soil. Because it is required in small amounts, it is important to deliver boron as evenly as possible across the field.

Functions of boron in plants:

- Boron is used with calcium in cell wall synthesis and is essential for cell
division (creating new plant cells). Boron requirements are much higher for reproductive growth so it helps with pollination, and fruit and seed development.

- Regulation of hormone levels and transportation of potassium to stomata (which helps regulate internal water balance).
- Boron plays an important role in carbohydrate and nitrogen metabolism metabolism, particularly in the translocation of photosynthates.
- Boron was considered to be involved in the translocation of sugars in the form of sugar borate complexes. These complexes pass more rapidly through cell membranes than the free sugars.
- Boron is required for the proper development and differentiation of vascular elements.

**Boron deficiency symptoms in plants:**

- Boron (B) exists primarily in soil solutions as the $\text{BO}_3^{3-}$ anion the form commonly taken up by plants. B is immobile in most plant species and symptoms appear first at tops and roots.
- Flower formation is less, sterile and seed production usually impaired and results in empty pollen grains, poor pollen vitality and a reduced number of flowers per plant. Its deficiency is often found to associate with sterility and malformation of reproductive organs.
- Root growth is stunted. The youngest leaves are misshaped, wrinkled and are thicker and of a dark bluish green color.
- Plants become dwarf, stunted with apical meristem blacken and die followed by general breakdown of meristematic tissue. Terminal leaves become necrotic and shed prematurely.
- Leaves show symptoms like distortion such as cupping and curling, appearance of white stripe, scorching, pimpling, splitted midrib and reduced growth.
- Stem shows symptoms like die-back of apex, abnormal tillering, and appearance of various forms of deformities such as curling and brittle lesions, pimpling etc.
- Adequate B is also required for effective nitrogen fixation and nodulation in legume crops.
- Fruits are severely deformed and develop typical cracking and stem splitting.

**Following diseases are commonly found due to B deficiency:**

- Heart rot of sugar beet and marigo
- Browning or Hollow stem in cauliflower
- Top sickness of tobacco
- Hard fruit of citrus
- Chicken and Hen disease in grapes

![Chicken and Hen disease in grapes](image)

![Browning or Hollow stem in cauliflower](image)
Environmental factors affecting boron deficiency:

- Environmental factors that reduce transpiration, such as high air humidity and low soil moisture, have adverse impacts on xylem transportation of B. Extended periods of drought impede B uptake by reducing root growth, limiting supply of B from organic matter reserves, and by depressing diffusion and transport of B to root surfaces.

- Plants under low B supply are more susceptible to damage from high light intensity associated with long and hot, sunny days.

- Under B deficiency, use of absorbed light energy in photosynthesis is significantly reduced, leading to an excess amount of energy and potential for leaf damage. Low soil temperature can also reduce root boron uptake.

Soil factors affecting boron deficiency in plants:

- Boron deficiency can occur when the pH of the growing medium exceeds 6.5, because boron is tied up and unavailable for plant uptake.

- Boron deficiency is highly prevalent in sandy acidic soils with low organic matter, due to the potential for B leaching.

- Soils with high adsorption and retention capacity are also commonly impacted by B deficiency.

- In most crops, B shows very poor phloem mobility. Consequently, B in leaf tissue cannot be transported sufficiently into the reproductive organs. Because of this poor mobility, keeping soluble B in soil solution during all stages of plant growth, particularly during reproductive growth is critical for optimal plant nutrition.

Soil-test of fields every two years to gain a thorough understanding of the nutrient levels of field. Because there is a fine line between deficiency and toxicity, it’s important to apply the correct amount of B at the right rate using the right source.

Plant analysis for boron:

To determine a plant’s B nutrient status, younger leaves are recommended for sampling and analysis. Typically, adequate B levels in dried leaf tissues range from 25 to 75 ppm B, which is a considerable quantity for many crops. Generally, a soil application of B is recommended when leaves contain less than 25ppm B in high-boron-demanding crops such as Sugar beets, Sunflower, Potatoes, Alfalfa and Soybeans.

Corrective measures: Foliar spray of 0.2% borax/boric acid will be effective for quick recovery. Liming of soil should be strictly avoided when boron-containing fertilizers are applied.

What factors make boron more available to plants?

- Finely textured subsoil’s with higher clay content tend to show the highest levels of boron, even when overlaid with a sandy top surface.
• Too much or too little pH, especially pH above 6.5 or below 5.0, tends to reduce boron availability.

• Microorganisms are crucial to the release of boron from organic compounds. Warm, moist, well-tilled soils with adequate aeration improve microbial activity and likely have better boron availability.

SUMMARY:

Boron deficiency renders decrease in cell wall plasticity leading to failure of newly divided cells to enlarge. As far as plasma membrane is concerned, adequate level of boron stops the accumulation of phenolics and ceases the oxidation of components of plasma membranes and also involved in the generation of H+ ATPase, which is a driving force for ion uptake. Boron accelerates nitrogenase activity through effective nodule development for nitrogen fixation. Plants reproductive growth is ceased with the deficiency of boron. This retarding growth is considered due to the low phloem mobility of boron. In brief, the formation of B complexes with the constituents of cell wall and plasma membrane as well as with the phenolic compounds is a major reason to affect the physiological functions of boron.

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