Review Article

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IMPACT OF BORON DEFICIENCY ON PLANT GROWTH

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Abstract: Boron (B) is a unique non-metal essential microelement for plants and constantly needed throughout plants life for normal growth and development. Boron deficiency became a world-wide problem in agricultural areas as its management is challenged due to the very minor difference in its deficiency and toxicity. The effects of insufficient B supply on various physical and growth parameters of plant can lead to plant death. The major roles of boron in plant development, the conditions which lead to deficiency, B deficiency symptoms and methods to overcome B deficiency are summarized in the present review work.

Keywords: Boron Deficiency, Micro Nutrient, Cell Division, Carbohydrate Metabolism

INTRODUCTION

Boron (B) is an essential element for plants and the only non-metal among the seven plant micro nutrient. In 1808 B was discovered by Gay Lussac and Thenard [1]. Boron plays an important role in plant growth and development.

Major roles in plant development: The role of boron in plants has been better understood after the significant and progressive research of last few years. It is a crucial micronutrient for growth and development of all plants and nitrogen-fixing cyanobacteria [2, 3].

Results of various researches concluded that boron is mainly involved in carbohydrate metabolism and cell division. Except these two it also affects at least 14 functions in plant. Apart from this many scientists has reveal that boron is very essential in carbohydrate synthesis and its translocation across the membrane towards meristem regions of roots and tops [4, 5, 6, 7, 8]. The second major role of boron in plant metabolism is cell division and maintaining the cell wall structure [9, 10, 11, 12, 13, 14]. Other findings also disclosed that boron is essential for cell division, differentiation, maturation, development and growth especially near the tips of shoots and roots. And it is crucial for cell wall structure and function [4, 15, 7, 8, 16].

Optimum level of Boron in plants and soil: The adequacy range for B in leaf tissue is from 10 to 50 mg/kg (ppm) of the dry weight. Significant B values vary from plant to plant being closer to either the lower or upper concentration of the adequacy range. It has been observed that boron accumulates in the leaf margins at concentrations 5 to 10 times that in the whole leaf blade [8]. Average B content in the soil is considered to be 30ppm. Soil boron exhibits a large variation depending on the parental rock. Consequently plants need trace amounts of boron but it becomes toxic at 20 ppm or greater for most plants [17].

Deficiency: Declined level of any of the essential mineral to plant health is called mineral deficiency. An unusual low mineral content can be defined as a level that may affect the function on that mineral [18]. B deficiency is one of the worldwide agricultural problem and a major drawback to crop production [3].

Conditions which lead to deficiency: Under natural surroundings, boron deficiency is a widespread nutritional disorder. Boron is more easily percolated form the soil than other trace elements and its deficiencies are normally related to high rainfall areas as well acid soil conditions. As boron is more water-soluble, it can therefore be leached below the root-zones of plants by rainfall or irrigations. Because of these sandy or free-draining lightly textured soils in high rainfall areas are more likely to be deficient. Moreover, availability of B decreases under drought conditions and as a consequence of a rising alkalization of the soil [2, 19, 15]. Soil lows in organic matters are more prone to boron deficiency because available boron is released from organic matter as it breaks down [15].

Deficiency Symptoms: Boron (B) deficiency symptoms have been described in detail even though it is the least understood of all eight important mineral micronutrient. B deficiency has been reported in 132 crops in more than 80 countries. It causes many anatomical, physiological and biochemical changes. However, it is difficult to distinguish between primary and secondary effects [3].

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Boron deficiency symptoms reflect the numerous functions fulfilled by boron in plant life and symptoms greatly differ between plant species. Sometimes the symptoms can be confused with other deficiencies or disorders (such as virus disease, frost or hormone damage) that cause distorted growth. They also differ depending on the severity of the deficiency. As Boron does not easily travel around the plant, deficiency is most expected to be seen in the younger tissues first [15]. Numerous biochemical, physiological, and anatomical effects of B deficiency have been reported in plants, bacteria, and animals [20, 21].

Boron deficiency symptoms are an expression of sugar deficiency in the cambia, stem tips, root tips, flowers and fruits [22]. Plants deficient in boron exhibit various visual symptom, like it continue to undergo cell division in growing tips without differentiation of cells which would otherwise result in cells becoming stems, leaves, flowers, etc.

As boron is involved in cell division and development, its deficiency kills vegetative growing tips which consists the meristematic cell line. Death of terminal buds directly affects the growth of lateral shoots, the tips of which may also be deformed or die leaving a rosette on the plant called "witches broom" condition. Leaves usually become thick, have a coppery texture and become curled and brittle and the growth of young leaves is inhibited. Tissue of boron deficient plants often breaks down prematurely, causing brown flecks, necrotic spots, cracking and corky areas in fruit and tubers [15, 20, 21, 8, 6, 2, 19, 23, 24].

Boron deficiency hampers flowering and fruiting by retarding pollen germination and pollen tube development processes. B deficiency reduces fertility and fruit development becomes slow or non-existent, depending on the severity of the deficiency. Sometimes plant fails to set flowers or in case if flowers can be set anyhow they are aborted due to B deficiency. Deformed flowers are a common symptom of boron deficiency [19, 8, 2, 7, 6].

At the cellular level, B deprivation harms numerous processes like cell wall synthesis, lignifications, cell wall structure, mitosis and cell elongation, along with of cell differentiation and development are badly affected and eventually brings about cell death due to boron deficiency. It also causes internal tissues to disintegrate, causing abnormalities such as distorted, cracked, or hollow stems [25, 6, 26, 27, 28].

According to Dugger [29], boron deficiency plays an important role in auxin biosynthesis in the meristem of the plant, thus its deficiency affects IAA metabolism. In 1974, Shkolnik [30] explained the physiological role of boron with the fact that auxin and phenolic compounds exhibit accumulation at the absence of boron. It also have been proved that in the B deficient condition the level of free auxin decreases, level of bound auxin increases and the IAA-oxidase activity reduces [26, 28, 31, 32].

Methods to overcome the boron deficiency: Knowing the nutrients required to grow plants is only one aspect of successful crop production. Optimum yield also requires knowing the rate to apply, the method and time of application, the source of nutrients to use, and how the elements are influenced by soil and climatic conditions. Trace element applications (boron, copper, iron, manganese, molybdenum, cobalt, selenium and zinc) are restricted in organic standards and applications can only be made following soil analysis or other evidence of deficiency. Since boron is non-mobile in plants, a continuous supply from soil or planting media is required for a better growth of plant [19]. The only way to overcome the boron deficiency is its external application. Boron may be applied to the soil as a straight boron material such as borax, or it may be purchased mixed with a fertilizer. Alternatively it can be dissolved in water and sprayed on to the crop or the soil. It can also be fed into the irrigation water.

Once laboratory testing has confirmed deficient boron, corrective action can be taken. Common products used for supplementing boron are Laundry Borax (11%B) or Solubor (20%B). The amounts used to correct low boron are on the order of one-half to one ounce of boron fertilizer per 1000 square feet. Application rates range from 1.0 to 3.0 lbs B/acre, depending on the crop [6]. A continuous supply of B is important for normal growth through vegetative and reproductive stages. But the usage of B fertilization needs to be tightly controlled because B accumulation potentially causes toxicity problems [18].

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