Importance of Boron in European Agriculture

David M. Schubert, Ph.D.
AvidChem LLC

All vascular plants require small amounts of boron for normal growth. The fact that plants are found growing in nearly all regions of our planet is evidence of the natural and widespread presence of boron in our environment. However, boron is not always present in optimal concentrations for specific plant species. This is true for many agricultural plants, including food crops and forestry trees important to the EU economy.

Boron plays a fundamental role in the structure and functioning of plant primary cell walls [1]. It likely also participates in other important plant functions, such as enzyme regulation. Vascular plants have developed complex transport systems specific to the regulation of their internal boron concentrations [2]. Boron is required for pollen tube formation and facilitates pollination and fruit and seed development. Without an adequate supply of boron, plants cannot grow normally, and flower, fruit and seed production are impaired. This can lead to substantial losses in crop yields. Boron is also required by nitrogen fixing bacteria found in the root nodules of certain plants [3].

While local soils may contain excessive amounts of boron, and this is a serious problem in some regions, a deficiency of this element is more common. In fact, boron deficiency is regarded as one of the most prevalent micronutrient scarcity problems facing global agriculture, and is responsible for substantial losses in crop yields, a host of plant diseases, and poor fruit and vegetable quality [4,5]. For this reason, it is common agricultural practice to apply borates to correct soil deficiencies where they occur. Depending on the crop, boron may be applied in various forms, including granulated borates for broadcast use and liquid borate solutions for foliar sprays. Granulated borates are often blended with NPK fertilizer for simultaneous application. Because some crops may be sensitive to over application, care must be taken to calculate accurate application rates.

The type of soil and annual rainfall can affect boron availability since relevant soil boron compounds are relatively soluble and can leach away. Light, sandy, and calcareous soils are prone to boron deficiency, whereas humic soils rich in organic matter can better retain boron. Boron deficiency with regard to specific crop types is widespread across the EU and is especially prevalent in Denmark, Finland, Germany, Greece, Poland, and Sweden [6].

Many crops important to the EU economy respond well to boron application, in the form of borates, when growing in soils having suboptimal boron levels. These include apples, cherries, hops, olives, rapeseed, sugar beets, sunflowers, and grapes. Dicotyledonous plants generally have a greater boron requirement than monocotyledonous ones, but the latter may also respond positively to boron application when deficiencies exist. Boron deficiency is most common in the EU where dicotyledonous crops are being grown in sandy and calcareous soils.

An adequate supply of boron is associated with improved yields and quality of many important crops. A few examples of boron deficiency problems follow:

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Apples: Inadequate boron in apples is associated with poor flower formation and fruit development. Deficiency can also result in deformed fruit and premature fruit drop. To avoid these problems, boron is usually applied to apples annually as a foliar spray prior to the critical stage of flowering and fruit set.

Olives: Although olive trees can grow in very poor rocky soils, they often respond well to boron application. Adequate boron is necessary for flower formation and the quality and stability of olive oil.

Sunflowers. B-deficiency in sunflowers in associated with distorted flowers and uneven seed set, or an absence of seed set. In severe cases no flowers are formed.

Hops. B-deficiency leads to browning and death of growing points and poor root development. Flowers may also turn brown and die, and cones that do develop may be small and brown. This greatly reduces yields.

Sugar beets: B-deficiency in sugar beets results in death of growing points and black heart rot.

Soybean: Most legumes, including soybeans, have a high boron requirement. Symptoms of B-deficiency in soybeans includes impairment of root growth and death of growing tips as well as reduced yields.

Maize. Although monocotyledonous plants generally have lower boron requirements, both the quality and yield of maize can be increased substantially when boron is supplied. Symptoms of B-deficiency in maize include stunted growth and poor cob and kernel development.

Forestry. When forest trees are boron deficient, development of their primary cell walls is impaired and root growth is inhibited. This ultimately has consequences for the structural development of the entire tree, leading to poor wood quality and losses in lumber production. Boron deficiency may also reduce resistance to pathogens. For this reason, boron application in deficient stands of commercial trees, such as Scots pine and Norway spruce, can result in significant economic benefits for lumber production and reduce carbon emissions from dead and decaying wood [7]. This is especially relevant in parts of Northern Europe, such as Finland, where boron deficiency is common.

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