# BORON

## Introduction

Boron (B) is a micronutrient that is essential in protein synthesis, seed and cell wall division and development, germination of pollen grains and sugar translocation. All crops need B throughout their life cycle but alfalfa is the only New York field crop for which B deficiency has been documented to date.

In this factsheet we describe the B cycle and give guidance for B management for field crops with special emphasis on alfalfa.

## Boron cycle

In soils, B is present in four forms: (1) soluble B (boric acid or $H_3BO_3$), present in the soil solution and directly plant-available, (2) mineral B, released to the soil by weathering of soil minerals, (3) B adsorbed onto the surfaces of clay minerals and iron hydroxides, released to the soil solution upon desorption from these mineral surfaces, and (4) B in organic matter, released to the soil solution upon decomposition of the organic material (microbial mineralization).

Of these four pools, the soil organic matter pool tends to contain the largest amount of B. In addition to supplying B through mineralization of organic matter, organic matter can also bind with newly added B so soil organic matter does not only supply B but can also regulate its release into plant-available forms. As a result, B-deficient soils that are low in organic matter will need more frequent B fertilization at lower amounts per acre than fields that have more organic matter.

Soil pH impacts B availability; it is most available in acid soils. As the soil pH increases above 6.5, B availability decreases more sharply. For crops such as alfalfa, which has both a relatively high B demand and a desired pH of 7.0, B deficiencies could occur, especially in fields that are low in organic matter and do not receive manure. Addition of lime can induce a B deficiency on such soils as well. Scouting for B deficiencies for alfalfa grown on such fields is recommended.

## Boron Deficiency

Boron deficiency is not common in New York soils. When it does occur, it is most likely to occur on acid, low organic matter, coarse-textured sandy loams, sands, and gravelly loams where prolonged drought reduces B supply from mineralization of soil organic matter. Acid sandy soils (well-drained soils) are most likely to be deficient because (1) B is in its most available form, and (2) it can easily be leached from the root zones. Clay soils with high organic matter levels are usually highest in B. However, in some heavier-textured (clay) soils, plant-available B may be low due to the strength by which B is held on the clay surfaces. In addition, recently limed soils can also be B-deficient.

Boron is highly immobile in the plant so for alfalfa B deficiencies are recognizable as yellowing and whitening of the youngest leaves and terminal bud. Boron deficiency also results in shortened internodes giving the plants an abnormal “bushy” appearance at the top of the stunted plant (rosette-like appearance).

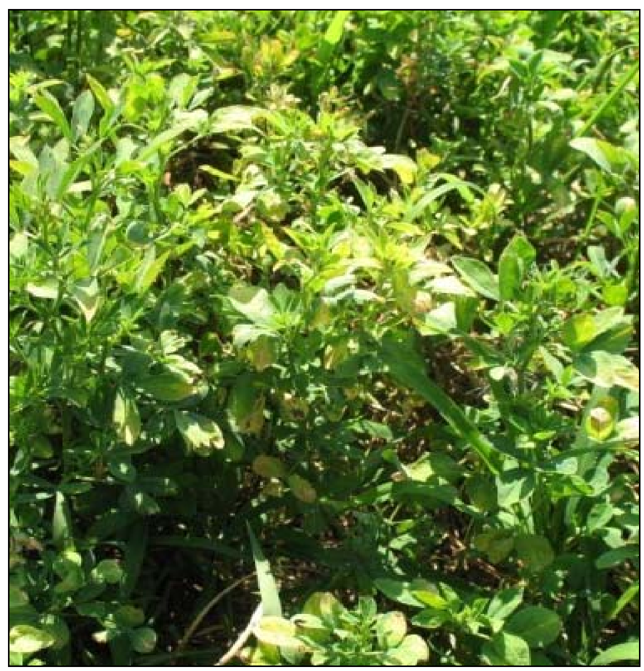

*Figure 1: Boron deficiency in alfalfa. Photo credit: Gordon Johnson, University of Delaware.*

Boron deficiency may look similar to leafhopper injury. Leafhopper injury has "V" shaped injury at tip of leaflet and yellowing of the leaf area around the injury. Leafhopper injury can occur on any leaf of the plant (not just the younger leaves). Under severe leafhopper infestations, an entire field can be affected. In contrast, B deficiency usually occurs in dry spots within a field rather than throughout the entire field.

**Boron Toxicity**

Excessive concentrations of B can cause reduction of crop yield and loss of quality as well. A B toxicity looks like yellowing of the leaf tips, interveinal chlorosis, and progressive scorching of the leaf margins. Boron toxicity is uncommon in soils of New York, unless fertilizers or municipal composts high in B have been added in the past. Of the field crops grown in New York, corn and soybeans are most sensitive to B toxicity.

**Boron Soil and Tissue Testing**

Both soil and tissue tests are used to determine a B deficiency. The most common soil test is the hot water B extraction. For New York field crops, if a hot water B test shows B levels of 0.76 lbs/acre or higher, the soil is classified as high in B and no B fertilizer addition is recommended. If the soil test is 0.35 lbs/acre or lower, the soil is B deficient and B addition is recommended. A soil test between 0.35 and 0.75 lbs/acre is classified as medium and B addition could be considered if the field shows a B deficiency. Although the soil test cannot predict how much B might be released from the organic matter decomposition during the growing season, the B soil test provides a guide for determining whether B fertilizer is needed for high boron-demanding crops. Tissue testing can be used to confirm a B deficiency. Alfalfa shoots should be sampled before or at 1/10 bloom stage (upper 3-4 inches). About 40-50 samples should be taken and combined. The critical tissue level is 20-30 ppm B, indicating that no B addition is recommended if the tissue test exceeds 30 ppm B.

**Boron Fertilizers and Management**

Boron removal is small as it is a micronutrient; a typical alfalfa yield of 5 tons of DM per acre would remove less than 0.5 lbs of B. If soil and tissue tests show a B deficiency, B can be applied as top dress at a rate of 1 to 2 pounds of B per acre for legumes and root crops (topdressed). Topdressing of B-containing fertilizer should be avoided for corn, small grains and beans as these crops are sensitive to excess B; corn can be injured by as little as 1 to 1½ lbs B/acre broadcast or a much lower rate applied in the row, especially on very sandy soils.

The most commonly used B fertilizers are Borax and sodium tetraborate. Solubor, sodium pentaborate, and boric acid are used infrequently for direct soil application or in a foliar spray. Boron is made more uniformly available to plant roots when mixed throughout the upper soil profile; plowing also speeds up the rate of organic matter breakdown, releasing B into the soil. As crop production systems shift to reduced tillage and no-till management, organic matter will accumulate on and near the soil surface and B availability will become more dependent on surface moisture and rainfall patterns. Manure contains B so application of manure could offset the need for B fertilizer.

**In Summary**

Boron deficiencies are most likely on acidic, low organic matter, sandy soils while well-managed medium to high soil organic matter soils are unlikely to be B deficient. Monitoring soil and plants can help to prevent yield loss due to a B deficiency. Boron should not be applied directly to crops sensitive to excess B, such as corn and soybeans.

**Disclaimer**



For more information

Cornell University Cooperative Extension

Nutrient Management Spear Program
http://nmsp.css.cornell.edu

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