A2522

Understanding Plant Nutrients

Soil and Applied Boron

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Boron (B) deficiencies in Wisconsin are more widespread than deficiencies of any other micronutrient. Soils may contain 0.5–2.0 parts per million (ppm) of available boron, but this represents only a small part of the total since only 0.5–2.5% of the total boron in the soil is available to plants. There is also a very narrow range between boron deficiency and toxicity as more than 5.0 ppm available boron can be toxic to many agronomic crops. Lack of boron often limits production of forage legumes (alfalfa, clover, trefoil) and of some vegetable crops in the state. Plants take up less than 0.5 lb/a boron, yet lack of this nutrient can reduce yields severely.

BORON REACTIONS IN SOILS

The storehouse for most of the boron in soils is the soil organic matter. As a result, most of the available boron is in the plow layer, where organic matter is highest. Soils low in organic matter are deficient in boron more often than soils with high organic matter content.

When the surface soil dries out, plants are unable to feed in the zone where most of the available boron is present. This can lead to boron deficiency. When rain or irrigation moistens the soil, the plants can again feed from the surface soil and the boron deficiency often disappears.

Somewhat like nitrates, boron is not readily held by the soil particles and moves down through coarse-textured soils, often leaching below the root zones of many plants. Because less leaching occurs on fine-textured silts and clays, these soils are not boron deficient as often as sands.

Soils with a pH of 7.0 or above are more apt to be deficient in boron than are acid soils. This is one reason for not applying lime when the pH of the soil is above 6.8.

FERTILIZER SOURCES OF BORON

Borax and sodium tetraborate are the most commonly used boron fertilizers. Solubor, sodium pentaborate, and boric acid are used occasionally for direct soil application or in a foliar spray. Table 1 lists the boron content of each of these carriers.

Method of Application

Alfalfa has a high requirement for boron, while corn, oat, and soybean have low requirements. On alfalfa, the easiest way to apply boron is in combination with topdressed fertilizers. If a soil tests low in available boron or if a deficiency appears, apply 0.5–1.0 lb/a of actual boron each year or 2 lb/a once in the rotation as a topdressing for forage legumes. The boron may be blended with any phosphate or potash applied. For forage legumes grown on sandy soils, an annual application of 0.5–1.0 lb/a of boron minimizes the leaching effect. Although boron leaches, it does not leach as readily as nitrate, and the deep roots of forage legumes can use boron leached from the surface.

Boron applied to forage legumes on loams or finer-textured soils usually provides adequate carryover for crops with moderate or low boron requirements such as corn, beans, and small grains. Never use a borated fertilizer in the row for corn or soybean, or in the drill for oat. The boron concentrated in a band is toxic to germination of these crops and may cause severe injury. Boron can be broadcast prior to planting corn, beans, or oat if the fertilizer is thoroughly incorporated into the soil. If a soil tests very low in boron for continuous corn, an application of 1 lb/a of actual boron every 2–3 years should be sufficient.

Table 1. Sources of boron.

MATERIAL	PERCENT BORON
Borax	11
Boric acid	17
Sodium pentaborate	18
Sodium tetraborate:	
Fertilizer borate - 48	14
Fertilizer borate - 65	20
Solubor	20

Crops vary in their need for boron. Crops with a high requirement include alfalfa, beet, canola, cauliflower, celery, sunflower, tomato, birdsfoot trefoil, and forage brassicas. Those with a medium requirement are apple, asparagus, broccoli, brussels sprout, cabbage, carrot, lettuce, melons, radish, red clover, spinach, tobacco, and vetch.

Table 2. Boron plant deficiency symptoms.

CROP	DEFICIENCY SYMPTOMS
Alfalfa	Death of growing tip, rosetting (bushy appearance) of the plant, and yellowing of top leaves
Beet	Brown heart and dark spots on roots
Cabbage	Internal breakdown of head
Cauliflower	Deformed foliage and browning of the curd
Celery	Brownish mottling of bud leaves and cracking of the stem

DIAGNOSTIC TECHNIQUES

Deficiency Symptoms

Boron is immobile in plants; hence, deficiency symptoms appear on younger tissue. Boron is involved in cell division, pollination, and cell-wall synthesis in plants. When deficient, the plants' growing points stop developing and will eventually die if the deficiency persists. Table 2 lists the typical boron deficiency symptoms for several crops.

Soil Analysis

Although boron soil tests are commonly used in Wisconsin, the test for available boron is not as reliable as the tests for phosphorus and potassium. Test reliability problems are due primarily to difficulty in predicting how much boron might be released from the organic matter during the growing season. Nevertheless, the boron test does provide a guide for determining whether boron fertilizer is needed for high boron-demanding crops.

Table 3 gives an interpretation of boron soil-test levels for various Wisconsin soils. The interpretation of the soil test for boron depends on soil texture and plant boron requirements. Where the crop requirement is high and the soil test is very low or low, apply 3 or 2 lb/a of boron respectively. Where the crop requirement is medium and soil test is very low or low, apply 2 or 1 lb/a of boron respectively. Where the relative crop need is low and the soil test is very low, confirm the boron need with plant analysis. To avoid boron toxicity, discontinue application of boron if the soil tests excessively high in this nutrient.

Plant Analysis

Analysis of plant tissue gives a good indication of the boron nutrition of plants. Because boron levels in the plant change with age, it is important to indicate the stage of development at sampling. Table 4 presents an interpretation of boron levels in leaf tissue for major Wisconsin field crops. For additional information, see Extension publication *Using Plant Analysis as a Diagnostic Tool (*A2289).

Table 3. Interpretation of the boron soil test.

SOIL TEXTURE	VERY LOW	LOW	OPTIMUM	HIGH	EXCESSIVELY HIGH
	ppm B				
Sands, loamy sands	<0.2	0.3–0.4	0.5–1.0	1.1–2.5	>2.5
Sandy loams, loams, silt loams, silts, clays	<0.3	0.4–0.8	0.9–1.5	1.6–3.0	>3.0
Mucks, peats	<0.5	0.6–1.0	1.1–2.0	2.1–4.0	>4.0

Table 4. Boron plant-analysis interpretations for common Wisconsin field crops.

			INTERPRETATION				
CROP	PLANT PART SAMPLED	TIME OF SAMPLING	DEFICIENT	LOW	SUFFICIENT	HIGH	EXCESSIVE
			ppm B				
Alfalfa	Top 6 inches	Bud	<20	20–30	30.1–80	>80	—
Corn	Whole plant	6–16 inches	<4	4–6.4	6.5–40	40.1–55	>55
Corn	Earleaf	Tassel to silking	<2	2–5	5.1–40	40.1–55	>55
Oat	Top leaves	Boot stage	—	<3	3–40	40.1–55	>55
Soybean	First trifoliate	Early flower	—	<20	20–50	50.1–80	>80

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