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BORON FERTILIZATION OF ALFALFA

(Revision of Factsheet ''Boron Requirements for Alfalfa'', August 1978) Harvey Wright, Plant Industry Branch

Boron is one of the micronutrients required by all plants for normal growth. Ontario soils contain sufficient boron to meet the needs of most field crops grown here. Alfalfa is a major exception. This crop has a high requirement for boron and this micronutrient is the one most likely to be deficient for alfalfa. As improved management results in higher yields of alfalfa, the rate of removal of boron from soils is increasing. Deficiencies show up mainly on sandy loam soils, and particularly on the high pH sandy loam and loam soils east of the Niagara escarpment. Boron shortage on clay loam and clay soils is rare. Where required, boron fertilizer use can result in a significant increase in both yield and persistence of alfalfa.

Boron Deficiency Symptoms in Alfalfa

A shortage of available boron results in a yellowing or reddening of the upper leaves of the plant. Lower leaves will stay green. The field, or patches in the field, will assume a bronze color. Stem growth between leaves becomes shortened, giving plants a stunted appearance. Numerous short side branches often develop near the top of the plant. Flowering is greatly reduced and flowers fall off without setting seed.

Boron deficiency symptoms can easily be confused with leaf discoloration caused by other factors. In identifying boron deficiency, note that the leaf discoloration occurs only on the uppermost leaves on the plant, and the entire surface of these leaves will be discolored, either yellow or red. Lower leaves will remain green. (This is because boron, once built into the leaf structure in the lower leaves, cannot be moved from these lower leaves to meet a shortage of boron for newly developing leaves.)



Figure 1. Typical bronzing of alfalfa due to boron deficiency under dry conditions.



Figure 2. Alfalfa plant showing bronze or yellow leaves and dead growing point caused by boron deficiency.



Figure 3. Bronzing in alfalfa. Closer examination would be needed to determine whether cause is boron deficiency or leafhopper injury.

Leafhopper feeding on alfalfa can give alfalfa fields a bronzed appearance very similar to that produced by boron deficiency. However, on examination of individual plants, it will be noticed that the discoloration appears on both upper and lower leaves. Also leafhopper feeding usually results in discoloration of only part of the leaflet, in a typical V-shaped pattern (Figure 4). Potassium deficiency results in yellowing, often with white dots, on the edge of the leaflets, but the centre of the leaf will stay green (Figure 6). The disease verticillium wilt also results in discolored leaves, but all the leaves on the plant turn color, and the typical color is a tan brown. Only boron deficiency causes yellow or red discoloration of the entire leaflet, on the top portion of the plant.



Figure 4. Typical V-shaped discoloration on alfalfa leaflets, caused by leafhopper feeding.

Boron Availability in Soils

Boron is most available in soils with pH between 5.0 and 7.0. Availability drops as pH rises from 7.0 to 8.0. Boron deficiency is more common in Ontario on high pH soils. This deficiency may also show up on acid sands, due in this case to leaching of the available boron from the soil by rainfall.

A large part of the boron in soils is found in the organic matter in the topsoil. Subsoil boron levels are normally much lower. During periods of drought, alfalfa roots cannot absorb boron in the dry upper layer of soil and are forced to feed in the subsoil area, where boron levels are low. This explains why boron deficiency in alfalfa is almost always associated with or made worse by drought. In fact, boron deficiency symptoms are often mistaken for a simple reaction to drought and referred to as "dry weather disease". Drought will reduce alfalfa growth, but will not produce boron deficiency symptoms if there is sufficient boron in the soil.

Because of the relationship between boron, organic matter and soil moisture, deficiency symptoms are rarely uniform throughout a field. Eroded knolls low in organic matter often are the first areas to show symptoms. Under dry conditions, symptoms show up first in the drier areas of the field and gradually spread. On fields where soil texture varies from sandy loam to clay loam, deficiencies often show up on the sandy areas and not at all on the clay areas. Likewise, deficiencies may occur on a field one year during a period of drought, but not be noted at all the following year. Deficiencies occur more often on aftermath growth in July and August (because periods of dry soil conditions are more common then), but can occur in the first cut.

Methods of Determining a Need for Boron

The need for boron has usually been determined in Ontario by identification of the characteristic deficiency symptoms on the plant.

Several laboratories, including those at Agri-Food Laboratories and at Land Resource Science Department, University of Guelph offer for a fee plant analysis for boron. At least 50 alfalfa plants, cut at normal mowing height at the late bud stage, should be submitted for analysis. Levels of boron in the plant lower than 20 ppm are considered deficient and will probably result in yield loss.

A problem with plant analysis for boron is that alfalfa sampled while growing under good soil moisture levels may show no shortage of boron. However, this same stand may show boron deficiency symptoms if drought conditions arise later. Plant analysis may be of most use to confirm that discolored alfalfa is due to boron deficiency rather than some other cause. While soil tests for boron are conducted by some labs in Ontario, the results are not considered to be very reliable in predicting the need for boron. The soil test can identify soils with pronounced deficiencies but has not consistently identified soils where seasonal deficiencies due to dry weather are likely to occur. Boron deficiency often occurs when the available level of soil boron is somewhat below 1 ppm. The precise reading at which deficiency occurs will vary with the texture, organic matter content and distribution, and moisture of the particular soil.

Effect of Boron Application on Alfalfa Stands

Yield response to boron application will vary depending on soil moisture levels throughout the season, thickness of the alfalfa stand and supply of other nutrients. However, yield responses of 1200 kg/hectare additional forage have been obtained from boron application to deficient alfalfa stands in Ontario.

Boron applications can also improve the quality of forage harvested. When boron deficient alfalfa is cut, the deficient leaves dry much faster than the stems, and are often lost in raking or baling. This leaf loss causes protein levels in the forage to drop significantly.

Alfalfa plants weakened by a shortage of boron have less winterhardiness. The stand will begin to thin out, further reducing the quality and yield of forage in following years.



Figure 5. Boron injury to oats caused by drilling a fertilizer containing boron.

Correcting Boron Deficiencies

The amount of boron required to correct a deficiency in alfalfa will vary, depending on soil texture and the level of boron in the soil. Sandy soils require less boron than loam soils to correct a deficiency, if both soils contain the same amount of boron. However, sandy soils often have lower levels of boron than loam soils. Boron deficiency can usually be corrected with an application of 1 to 2 kg/ha of boron, broadcast annually. Highly deficient soils may require 3 kg/ha annually.

Crops differ in the amount of boron which they require. White beans, soybeans, peas, wheat, oats and barley require much less boron than alfalfa and have a low tolerance to excess boron. Boron should never be applied to these crops unless specialist advice has been obtained. If these crops will be grown in rotation with alfalfa, do not exceed recommended rates of boron on alfalfa. Use caution in applying boron to an alfalfa stand which will be plowed for planting to a different crop in less than a year. Peas and beans and under certain conditions cereals and corn can be injured by residual boron left from a recent application.



Figure 6. Potash deficiency symptoms, much different from those caused by lack of boron.

Sources of Boron Fertilizer

Table 1 lists the more commonly available materials in Ontario used to supply boron. The first three products are of suitable granular size to bulk blend with granular fertilizers. Fertilizer borate 48 is used in granulating plants or in making suspension fertilizers. Particle size of this material is too small to mix and spread with granular fertilizers without segregation problems. Solubor is the source of boron commonly used in liquid fertilizers and for foliar spray or dust application.

Table 1. Boron Fertilizer Materials

Product Name	%Boron	Kilograms of product to supply 1 kg of Boron	
Fertilizer Borate Granular (46)	14.3	7.0	
Granular Fertilizer Borate 44	13.7	7.3	
Granular Boron 120	12.0	8.3	
Fertilizer Borate 48	14.9	6.7	
Solubor	20.5	4.9	

Methods of Applying Boron

From Table 1, it is evident that the amounts of boron required to correct a deficiency are relatively small. It is usually not practical to broadcast straight boron materials. The most satisfactory application method is to blend boron at a fertilizer plant with phosphorus and or potash. A soil test will determine the amounts of phosphorus and potash required by the alfalfa. Once the rate of fertilizer has been determined, consult Table 2 for the amount of granular boron material which must be blended into a tonne of fertilizer to give an application rate of 1 kg/ha.

Table 2. Amounts of various boron materials to be added to 1 tonne of fertilizer to give 1 kg/ha* of boron at different fertilizer application rates

Fertilizer Rate (kg/ha)	Kg of boron material per tonne of fertilizer to supply 1 kg/ha* of boron			
	Borate 46	Borate 44	Boron 120	
	(14.3% B)	(13.7% B)	(12% B)	
100	75	79	91	
200	36	38	44	
300	24	25	29	

*If the desired rate is 2 kg/ha of Boron, double the above figure.

Solubor is a source of boron which can be dissolved in water and sprayed on an alfalfa field using a field sprayer. At rates to supply 1 to 2 kg/ha boron, application must be made very shortly after cutting, to avoid burning of new growth. If the boron solution is being sprayed on alfalfa foliage, the maximum amount of boron per application to avoid injury is .5 kg/ha. Several applications per year, or a later application of a granular boron source, would be needed to supply total boron needs on deficient soils. Careful calibration of the sprayer is important.

Time of Application

Boron is best applied to new seedings of alfalfa in the fall of the seeding year with a fertilizer top-dressing. Never drill in a fertilizer containing boron when seeding down alfalfa under a cereal companion crop. The cereal crop would be severely injured or completely killed. If in certain direct seeding situations, boron is to be applied at seeding time, it should be broadcast rather than banded, to avoid possible injury to grasses in the forage mixture.

Once the forage stand is established, boron can be applied with fertilizer any time during the season. Boron is a fairly soluble material and is readily moved into the alfalfa root zone by rainfall.