AG-FO-0723
Revised 1983
G.W. Rehm and W.E. Fenster
extension soils specialists

BORON for minnesota

Agricultural Extension Service • University of Minnesota

Boron (B) is used in relatively small amounts for crop production and is therefore classified as a micronutrient. The majority of Minnesota soils are capable of supplying adequate amounts of boron for crop production. Research in Minnesota has shown, however, that using boron fertilizers will improve the yield of alfalfa and vegetables on some sandy soils. Where needed, boron use can be profitable.

Boron's Role in Plants

The specific function of boron in plant growth has not been well defined, but it is known that boron functions in the utilization of carbohydrates. In addition, boron plays an important role in the movement (translocation) of water and plant nutrients from the root to the plant's growing portion. The total quantity of boron used by plants is very low. For example, a good alfalfa yield will remove from .1 to .2 lb of boron per acre.

Deficiency Symptoms

Boron is not mobile in plants. Deficiency symptoms will therefore occur on the plant's upper portion which becomes stunted.

With alfalfa, stunting of the new growth gives the plant a bushy, umbrella-like appearance. The lower (older) leaves stay green. Severely affected plants do not produce blossoms, an extensive yield loss occurs, and plants winterkill easily. When the deficiency is severe in alfalfa, the growing point dies. If boron is supplied at this stage, side branches will grow and develop normally and extend above the stunted main stems (see figure).

Alfalfa that is partially affected by boron deficiency may have many short-growing plants among tall, healthy ones. No deficiency symptoms show up unless one leans the taller plants to the side and looks beneath them. Under these conditions, a boron shortage can reduce yields by 15 to 20 percent.

In corn, a boron shortage causes barren stalks and small, twisted ears.

Deficiency symptoms in vegetable crops are varied. In general, there is restricted terminal growth with wilted, curled leaves. Roots, tubers, and fruits show rotting, cracking, and discoloring.

Soils Where a Response to Boron Could Be Expected

In Minnesota, a response to boron use might be expected on soils that have a sandy loam, loamy sand and sand texture with a low organic matter content. The majority of boron in soils is contained in the organic matter. As decomposition of organic matter takes place,

Figure 1. Boron-deficient alfalfa. Arrow on left shows a dead growing point. Arrow on right shows what happens when boron is supplied; a side branch extends above the dead main stem. (Picture from Pine County.)

boron is released for plant growth. Breakdown of organic matter is nearly stopped during dry weather. As a result, boron deficiency symptoms are more likely during dry weather periods.

Boron is readily leachable in sandy textured soils. Therefore, boron deficiencies might occur more often on sandy soils under irrigation. Special attention should be given to boron levels when alfalfa or vegetable crops are grown on Minnesota's irrigated sandy soils.

Crops vary in their boron need. Table 1 shows the type of response to boron that might be expected from various crops.

Table 1. Relative differences of several crops in their response to boron applied to boron deficient soils

Large response	
Alfalfa	Cauliflower
Sugar beets	Celery
Moderate response	
Tomato	Clovers
Cabbage	Lettuce
Carrots	Radish
Small response	
Field corn	Pasture grasses
Sweet corn	Rye
Wheat	Potatoes
Barley	Soybeans
Oats	Blueberries

Predicting the Need for Boron Through Soil and Tissue Tests

In areas of Minnesota where there is a possibility of a response to boron use, the boron status of crops can be monitored by using tissue analysis. The relative boron levels in plant tissue for some major agronomic crops are listed in table 2. Since excessive amounts of boron can cause problems with some crops, boron application in a fertilizer program should be stopped if the boron concentration in the plant tissue is in the sufficient or high range.

Table 2. Relative levels* of boron in parts per million (ppm) for major crops

Crop	Plant part	Time	Deficient	Low	Sufficient	High
			——ppm——			
Alfalfa	Upper 1/3	Harvest (1/10 bloom)	<20	20-30	31-80	>80
Corn	Leaf opposite ear	Silking	<2	2-5	6-40	41-55
Soybeans	Fully developed upper trifoliate	Before pod set	—	<20	21-55	56-100
Sugar Beets	Leaf		<10	11-20	21-50	>50
Sugar Beets	Petiole		<8	9-15	16-200	>200

* adopted from *Soil Testing and Plant Analysis*, SSSA, 1973.

Tissue analysis, however, cannot be used as the only indicator of a need for boron in a fertilizer program. For example, the boron content of some alfalfa grown on the silt loam soils of southeast Minnesota has been less than adequate if the standards listed in table 2 are used. Yet, boron application to these soils has not increased yields in research trials. In this case, the plant samples were collected in a year when rainfall was limited. Boron uptake was reduced under dry conditions. In addition, the amount of boron released from the organic matter is reduced when rainfall is limited.

Soil testing can also be used as a management tool in predicting the need for boron application. A boron soil test is now available through most soil testing laboratories.This test is especially appropriate for sandy soils where a response to boron might be expected. Current suggestions for boron use in a fertilizer program are listed in table 3.

Table 3. Relative boron levels in soil and suggested application rates

Boron Soil Test	Relative Level	Alfalfa	Vegetables	All Other Crops
ppm		— — — — lb B to apply/acre — — — —		
0-.9	low	2-4	0.5-1.0	0*
1.0-5.0	adequate	0	0	0
more than 5.0	excessive	0	0	0

*Although the boron test is low, research has shown that crops other than alfalfa and vegetables have not responded to boron application.

Method of Application

Broadcast applications instead of row treatments are recommended. Boron can be toxic to the germinating seed if it is applied in contact with the seed. The broadcast applications should be made one to two weeks before seeding.

A broadcast application of boron to alfalfa will usually last for more than one year. A common practice, on known boron-deficient soils, is to use a borated fertilizer mixture once every three years.

Foliar sprays can be used on severely deficient fields. Use 0.1 to 0.3 pound of boron per acre for foliar sprays. **CAUTION:** do not spray on hot days when the crop is under moisture stress.

Boron Fertilizers

Boron fertilizers can be easily blended with other common fertilizers. Table 4 lists some common boron sources along with their formulas and concentrations.

Table 4. Boron sources that can be used in Minnesota*

Material	Formula	Percent Boron	Quantity needed to supply 1 lb B/acre
		%	lb
Borax	$Na_2B_4O_7 \cdot 10H_2O$	11	9.1
Borate 48+	$Na_2B_4O_7 \cdot 5H_2O$	15	6.7
Borate 68+	$Na_2B_4O_7$	21	4.8
Solubor+	$Na_2B_8O_7$	20	5.0
Boric acid	H_3BO_3	17	5.9

*From *Fertilizers and Soil Amendments* by R.H. Follett, L.S. Murphy, and R.L. Donahue.

+Brand name materials. Mention of the brand name materials does not constitute endorsement by the University of Minnesota over similiar products that might be commercially available.

Boron in Sewage and Manure Wastes

Boron in manure is usually very low, ranging from .02 to .12 pound per ton. At the highest concentration, a

rate of 20 tons per acre would barely meet the boron needs where boron deficiencies are known.

Also, sewage sludge is not considered a good boron source.

Too Much Boron

Unlike most other plant nutrients, using excessive amounts of boron can cause problems with some crops.

For example, applications of 1 to 1.5 pounds of boron per acre close to the seed have reduced corn germination. In some Minnesota trials, using excessive amounts of boron reduced the yield of soybeans grown on an irrigated sandy soil (table 5). A systematic soil testing program should be used to monitor the boron content of soils to avoid excessive boron application.

Table 5. Effect of applied boron on the yield of soybeans grown on an irrigated sandy soil. Dakota County.

Boron Applied	Soybean Yield
lb/acre	bu/acre
0	36
1	34
2	32
4	27

Source: Fenster and Grave, 1982.

Summary

Many sandy soils in Minnesota do not provide adequate boron for crop production, especially during dry periods of the growing season. Soil tests and plant analyses have been developed as management tools to predict where and when boron will be needed. If needed, using boron in a fertilizer program can produce substantial production increases of some crops, resulting in improved net profit to the grower.

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