Soil
FACTSHEET

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Boron for Field Crops

INTRODUCTION

Boron (B) is a micronutrient essential for plant growth. Plant requirements for boron are critical, but only small amounts are needed to provide adequate growth, hence, it is categorized as a micronutrient. Deficiencies of boron are widely reportedly across British Columbia except in the Peace River region. Many crops have had yield reductions due to low boron.

PLANT REQUIREMENTS AND BORON DEFICIENCY SYMPTOMS

Boron regulates the transport of sugars through plant cell membranes, the rate of cell development, cell division, and the synthesis of proteins. Plants are unable to mobilize boron from the old to new plant tissues. Deficiency symptoms of the plant are first noticed at the terminal growing points: new leaves, flower buds, stem tips.

When soil boron levels are low, crops have very specific boron requirements. Legumes and canola have high boron requirements, while grasses and cereals have low requirements. Each crop develops specific visual symptoms when boron is deficient. Minor deficiencies may result in reduced yields but have few of the visible boron deficiency symptoms.

Alfalfa

At the growing tips of plants, the youngest leaves turn yellow, then red, progressing to a light brown colour. The main stem between leaf offshoots becomes shorter, and the growing tip develops a rosette appearance. Older, bottom leaves retain their colour. The plant develops a stunted appearance. Flowers may fail to form or are delayed. Buds will turn white or light brown when the deficiency is severe.

Clovers

Leaf symptoms are similar to alfalfa, but there is a tendency for more reddish or purplish colours to develop. Stems at the tips become thickened.

Cereals

Boron deficiencies in cereals are rare, despite low soil boron levels. Wheat will form a normal head, but does not flower. Barley does not form heads, while oats do not develop full pollen grains. All cereals will show thickened stems with a tendency for leaves to curl.

Canola

The leaves of canola will curl and stem growth stops. Darkened water spots may be visible on the stems. Often there is less flowering. A poor seed set occurs with seed pods developing, but containing immature or sterile seeds.

Boron Soil Tests

Boron requirements are best predicted by soil tests, rather than tissue tests for annual and perennial field crops. The most common boron extraction method used by soil test laboratories is a hot water extraction procedure (hwB). **Table 1** indicates the recommended fertilizer rates to apply at various soil boron levels using the hwB procedure. Adjustments for crop tolerance are incorporated into the recommendations as can be seen in **Table 1**.

Table 1 Boron Fertilizer Recommendations†

Available Soil Boron (hwB)* ug/ml(ppm)	Boron Rating	Grasses Cereals	Alfalfa, Clovers, Canola
		····· kg B/ha ·····	
<0.20	Very low (VL)	1	5+
0.21 – 0.40	Low (L)	1	4
0.41 – 0.60	Medium (M)	0	3
0.61 – 0.80	Medium (M)	0	3
0.81 – 1.00	High (H)	0	2
>1.00		0	0

† Recommendations for other crops can be found online in "Soil and Plant Tissue Testing Methods and Interpretations of Their Results for British Columbia Agricultural Soils"

**hot water soluble boron*

+High rates should not be repeated annually without monitoring soil and tissue levels to avoid a buildup of toxic born levels.

Table 2 lists the most common boron fertilizers, analysis, and recommended application rates.

Table 2

Boron Fertilizers & Application Rates According to Soil Test Recommendations

Name	Boron	Fertilizer Type	Boron Fertilizer Rate				
	%B		Soil Test Recommend kg B/ha				
			1.0	2.0	3.0	4.0	5.0
			Fertilizer App. Rate kg/ha				
1. Borax	11.0	Powder	9	18	27	36	45
2. Borate-40	12.5	Prilled	8	16	24	32	40
3. Borate-48	14.3	Granular	7	14	21	28	35
4. Borate-68	20.2	Granular	5	10	15	20	25
5. Solubor	20.5	Liquid	5	10	15	20	25

Boron Fertilizers

Boron is available in granular, prilled, powder, or liquid forms. Sodium tetraborate, ($Na_2B_4O_7 \cdot 5H_2O$) is the most common boron fertilizer material. Borax ($Na_2B_4O_7 \cdot 10H_2O$) and sodium pentaborate ($Na_2B_{10}O_{16} \cdot 10H_2O$) are other common boron fertilizer materials.

Borate-68 is the highest analysis boron fertilizer (20.2% B). It is sold in two mesh sizes: coarse and granular. The granular form is suited for blending with other fertilizers or direct application.

Borate-48 has a lower analysis (14.3% B), and is in a very fine granular material. It does not dry blend well with other fertilizers, and has low solubility. It is used by fertilizer companies to make special fertilizer blend involving other processes than dry mixing. This material is not as well suited for foliar applications as other boron fertilizers.

Borate-40 has a low analysis (12.5% B), but it is produced in a prill form. The prill size is similar to urea (46-0-0) but has a wider prill size range. It is intended for blending with other dry fertilizers. The prilled Borate-40 allows for a uniform distribution when spread alone, and there is much less segregation in the field spreaders when blended with other fertilizers.

Solubor is a very soluble boron product (20.5% B). It is most often used as a foliar fertilizer, but it may be applied to soil prior to seedbed cultivation.

BORON MANAGEMENT

Soil Applications

Boron can be spring or fall applied to both perennial and annual crops, except on coarse textured sands or gravelly soils, which should only receive spring applications. Banding or seed placing boron fertilizer should be avoided to prevent localized toxicity unless cultivation follows banding. Broadcast boron should be followed by incorporation to the full cultivation depth before seedbed preparation. Surface broadcast application on hay crops is an effective application technique.

Foliar Application

Field crops are rarely treated with a foliar boron application. Several applications per year of foliar boron is usually necessary due to the lack of boron mobility in plants. Foliar boron applications at an early growth stage cannot supply all the boron requirements on a low boron soil. Higher foliar boron rates could be used if followed by substantial rainfall or irrigation, ensuring that only a small portion is absorbed by the crops' foliage with the remainder washing off, entering the soil and thus the plant's roots.

Boron can be mixed with some pesticide sprays in a combined foliar operation, reducing application costs. Check for compatibility between the desired pesticide and soluble boron products (Solubor).

Residual Effects

Residual boron (from previous years' applications) persists in some soils for up to 3 to 4 years. This is dependent on the boron rate, soil type (texture), amount of irrigation, or rainfall. Most recommended boron fertilizer rates have a life expectancy of three years on all but sandy soils under irrigation.

BORON TOXICITY

Excessive boron can be toxic. Overfertilizing or concentrating boron near seedling crops can result in toxic levels, and some crops are very sensitive to boron. Banding boron can have positive results if concentrations are carefully considered and seed is placed at adequate distances from a band. Since it is possible that toxic conditions could arise near a band, cultivation after banding is recommended. Soil boron levels greater than 2 ug/ml (2ppm) are a signal that boron is available in concentrations which may affect sensitive crops. Soil concentrations greater than 3 ug/ml (3ppm) indicate that the potential for toxicity exists.

Alfalfa and canola have an ability to withstand higher soil boron concentrations than clovers. Cereals and grass crops are the most sensitive to high boron levels. Barley has the highest sensitivity to boron, followed by wheat, then oats. Toxicity symptoms are most pronounced on barley.

Symptoms start on the older leaves (bottom) with severe brown spotting and burning of older leaf tips, and progress to the leaves' middle portion. Leaf spotting may not be noticeable in wheat or oats. Toxic symptoms in wheat appear as light browning of older leaf tips, converging into light greenish blue spots. On oats, the leaf tips may be a light yellow.

To avoid boron toxicities:

a) Apply boron early in a crop rotation, so that residual levels will not affect sensitive crops.

b) Avoid concentrating boron in bands at levels recommended for broadcast applications.

c) When broadcasting boron, avoid fertilizer overlaps in field or at headlands.

d) Banding should be followed by cultivation before drilling a sensitive crop such as cereals. Alfalfa and canola may withstand boron banded without incorporation if the correct rate is used.

e) Apply boron at the recommended rates. Recommended rates will provide sufficient boron for up to 2 to 4 years in the Central Interior. Rates higher than recommended levels could cause toxicities.

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