
Boron deficiency is the most common micronutrient[3] limitation in forest plantations. It occurs in many countries, particularly in exotic plantations of eucalypts and pines, but also in plantations and natural stands of native species on soils altered by macronutrient fertilization, liming, fire or erosion.

## Deficiency symptoms

Deficiency symptoms are usually characteristic but can be confounded by variable foliar concentrations, erratic occurrence, and possible climatic damages. Boron deficiency symptoms[3] on pines vary by species and may be distinctly seasonal in occurrence and are often environmental stress induced. Spring growth from unaffected buds appears normal, and it is not until midsummer or later that leading shoots show clearly recognizable symptoms. Limited supplies or even brief interruptions (such as those caused by drought) in absorption of boron can cause irreversible damage to rapidly growing shoots. A split leader is often the outcome.

*Pinus sylvestris* (a uninodal species): Exhibits abundant resin flow and various disturbances in apical dominance as the first external evidences of boron deficiency. The terminal bud may be small, malformed, retarded in expansion, or dead. Adjacent lateral buds may or may not be similarly affected. Swelling, cracking, bending, or dying of the leader occurs as in other pine species and so also darkening and formation of cavities in the pith. Needles near the affected tips are often short and deformed, either dark green, or discolored.

Other symptoms noted in various species are:

- *Pinus stobus* and *Pinus sylvestris*: Dieback of terminal growing points. Tips of the primary needles turn light yellow/orange in color and have light brown edges.
- *Pinus sylvestris*: Seedling are short with thick, succulent, and somewhat fragile roots. The buds, which are small, remain moribund and the young needles chlorotic. Malformation of the needles is common.
- *Pinus radiata*: Shoot and tip dieback, dead tops and malformation, and brown root tips with extensive surface cork development. The shoot growing point of a seedling not supplied with boron died after five months.
- *Thuja plicata*: Growing shoot wilts readily and the needles on young shoots become bronzed.
- *Pinus patuls*, *P. khasya*, and often in *P. caribaea hondurensis*: The leading shoots became very crooked but were otherwise healthy with normal foliage and no resin flow.
- *Pinus elliottii*: Resin flow, bud death, and tip dieback symptoms. Needle malformations often occur before other external symptoms.

Agronomy Note

# Boron in forestry production

## Boron and tree physiology

Boron is a relatively immobile nutrient within plants. Unlike many other nutrients (eg nitrogen and magnesium), it is not redistributed to growing points by internal cycling. Current uptake by the roots appears to determine the concentrations that are incorporated into shoots and foliage as they are formed.

Fertilization with boron[2] increases the total carbohydrated content of mycorrhizal roots. Foliar + soil fertilization yielded a 24% increase in total carbohydrates in mycorrhizal roots, whereas foliar fertilization alone decreased the total carbohydrate content. Significant increases in sugars in response to boron fertilization were observed in both ectomycorrhizal and nonmycorrhizal plants. Low boron availability limits growth of roots, and deficiency affects mycorrhizal symbiosis more than fine roots alone.

Leaves may have a light mosaic pattern of chlorosis in interveinal areas and red-brown spots interveinally and on the margins. Roots may remain short, thicken, swell into knots and break open longitudinally.

## Where is boron deficiency most common?

Boron deficiency was most common on:

- Soils from acid igneous rocks and fresh water sediments
- Acid soils from which the original content has been leached
- Sands low in silt, clays or micas, acid peats and mucks
- Soils with free lime, including some acid soils after heavy liming[3]

Overt manifestations of boron deficiency and/or reduced foliar boron may be induced by addition of macronutrients[3]. Liming and nitrogen fertilization[4] can cause serious boron deficiency. It is likely that liming affects uptake of boron, whereas nitrogen fertilization causes a dilution due to increased growth.

Environmental stresses, especially drought, often induce[6] or accentuate boron deficiency on marginally deficient sites. Although trees usually recover with resumption of normal rainfall, the incidence of multiple leaders in affected stands may be high and this reduces their economic value. Applications of boron have been observed to prevent dieback even when years of drought followed the boron application.

## Soil test and plant analysis

Soil tests are most useful to determine pH and establish sufficient nutrient levels before planting, but a foliar sample[5] is needed to determine how well the tree is utilizing the soil nutrients. North Carolina State University recommends sampling at the completion of each growth flush when shoots have stopped growing and needles are fully elongated.

Studies in Austrialia[6] with hot-water soluble boron in the 0-10 cm and 10-20 cm horizons of 0.29 and 0.19 ppm caused severe boron deficiency symptoms in *P. radiata* seedlings. Soil test values are not always well correlated with plant tissue values.

## Agronomy Note

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## Boron recommendations for forestry

Christmas tree (Fraser Fir)[1] boron deficiencies have been treated with foliar application of *Solubor*® (1 lbs per 100 gal) or ground applied sprays of *Solubor* (3 to 5 lbs per acre).

Do not exceed 0.25 lbs boron per 100 gallons for foliar application to Christmas trees. Applications of 5 lbs of boron / acre was adequate to correct boron deficiency in *P. radiata* under drought conditions[6].

| Tissue concentrations | | | | | |
|---|---|---|---|---|---|
| | Leaf boron content, ppm boron | | | | |
| **Crop** | **Deficient** | **Low** | **Normal** | **High** | **Excess** |
| Birch | <14 | | 28-33 | | |
| Eastern cottonwood | <9 | | 68 | | |
| Eucalyptus | <35 | | 40-70 | | |
| Holly | <20 | 20-25 | >30 | | |
| *Pinus radiata* | <10 | | | >20 | |
| Rubber | | | >80 | | |
| Scots pine | <10 | | 25-30 | | |
| Spruce | *8 | | 25-30 | | |

*Diagnostic Criteria for Plant and Soils* Ed. H.D. Chapman.
Shorrock - Boron Deficiency and Its Cure.

| Soil applications (suggested rates of application) | | | |
|---|---|---|---|
| | *Granubor*® (15% B) *Fertibor*® (15% B) | *Solubor*® (20.5%) | |
| **Crop** | **lbs / acre** | **lbs / acre** | **gals / acre** |
| Birch | 0.4 - 1.8 | 0.2 - 1.2 | 3 - 24 |
| Eastern cottonwood | 0.4 - 1.8 | 0.2 - 1.2 | 3 - 24 |
| Eucalyptus | 1.1 - 3.5 | 0.7 - 2.4 | 14 - 47 |
| Pines | 6.3 - 31.2 | 4.5 - 22.3 | 10.7 - 53.5 |
| Wattle | 12.5 - 37.9 | 8.9 - 26.8 | 21.4 - 64.2 |

Agronomy Note

# Boron in forestry production

## References


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