Trees Nutrition Series
(Summary Sheet)

WARNELL
School of Forestry and Natural Resources
The University of Georgia

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B BORON

element symbol

by Dr. Kim D. Coder, Professor of Tree Biology & Health Care
Warnell School of Forestry & Natural Resources, University of Georgia

element number	**5**
element family type	**METALLOIDS**
normal form of pure element at biological temperatures	**SOLID METALLOID**
average rounded atomic weight	**11**
number of native isotopes	**2**
concentration group	**DEKA-ELEMENT**
element concentration in tree (ppm)	**30**
element proportion in tree (carbon & oxygen levels = 450,000)	**65**
element concentration rank in tree (carbon & oxygen rank = 1)	**14**
relative tree concentration (compared to element in Earth's crust)	**<**
different chemical oxidation states	**2**
most stable chemical oxidation state	**3**
oxidation states within a biologic compound	**+3**
oxidation states as a biologic active center	**+3**
total oxidation state range in biologics	**1**

among tree essential elements --

relative atomic radius	**SMALL**
relative ionic radius	**----**
relative first ionization energy	**MEDIUM**
relative atomic density	**LOW**

other element family members (*toxic)	**Al*, Ga, In, Tl**
most commonly available tree form (form in bold dominant)	H_3BO_3 / borate

solubility of element's compounds --

borate insoluble = **O^{--}, S^{--}, OH^{-}, $CO3^{---}$**

borate soluable = **NO_3^{-}, SO_4^{--}, $C_2H_3O_2^{-}$**

Coder Element Interaction Matrix for Trees (CEIMT) Values

(+ = positive or synergistic; - = negative or antagonistic)

B	Ca	Cl	Co	Cu	Fe	K	Mg	Mn	Mo	N_a	N_n	Ni	P	S	Si	Zn
X	-	O	O	O	+-	+-	-	-	O	+-	+-	O	+-	O	-	+-

Boron (B) is a hard, brittle, brown solid called a metalloid discovered in 1808. Its name is derived from Persian for a boron containing compound. The rest of its elemental family are all metals. It is never found in pure form. It is used for cleaning products, water softening, antiseptics, heat resistant glass, nuclear reactor rods, and transistors.

Boron is a rare element and the lightest (except for hydrogen) element essential for trees. Boron is one of two essential elements (i.e. silicon is the other) usually present in a tree as a neutral molecule (undissociated form) rather than an ion. The concentration of boron can vary widely in tissues. Its form in a tree depends upon tissue pH, existing as boric acid ($B(OH)_3$ / H3BO3) where pH is less than 7.0 and the borate ion ($B(OH)_4^-$) where pH >7.5. Figure 1.

Boron deficiency causes many biological and structural problems in trees. Boron can act as an antibiological agent in trees and when it is in short supply pathogens attacks are more effective and move quicker. Both terminal meristems (shoot / root) are serious impacted by boron deficiency leading to damaged and death.

New tissue in boron deficient trees quickly become hard, dry, and brittle and leaf blades are stunted and distorted with tip and marginal yellowing, bleaching, and death. New tissue can show atypical periderm cracking and minute eccentric periderm growths (ridges and spots). Because boron is immobile once positioned in trees, new tissues show developing deficiencies first. Slowed root growth is a first symptom in boron deficiency.

Boron deficiency impacts many components in trees. Primary problems with shortages of boron occur in cell walls, membrane functions, and starch, protein, auxin, and nitrate processing. Cell wall structure and the middle lamella pectins between cell walls are strengthened and tied together with boron links. Cell membranes health is modified by boron. Nitrate use, general protein production, and associated RNA production and functioning are facilitated by boron. Boron impacts the production and storage of starch, modifies growth regulator stability (i.e. auxin), and helps govern lignin production.

Boric acid can be used as a simple boron fertilizer but can quickly become toxic, especially to new root tips. Boron containing cleaning materials in grey water systems can damage tree roots. Interestingly, boric acid added to acid soils can partially offset aluminum toxicity.

Tree Symptom Summary

Boron performs one dominant role in trees as part of cell wall structure. Boron helps bind pectic polysaccharides in and between tree cell walls. Deficiency symptoms can quickly occur physiologically and structurally.

When deficient, boron has been cited as generating the following symptoms:

tree part	primary symptom	element deficiency responsible
roots	stunted / damaged	B -- also Cl, Cu, Mn, N, Ni, P, K, S, Si, Zn
shoots	stunted / damaged / killed	B -- also Ca, Cl, Cu, Fe, Mn, Mo, N, Ni, P, K, S, Zn
secondary meristems	periderm cracking / atypical patches / localized growths	B -- also Cu, Ni
buds	distorted / death	B -- also Ca, Cu, Ni
young leaves	wilting	B -- also Cl, Cu, K, Mo, Zn
leaves	color – general chlorosis	B -- also Cl, Cu, Fe, K, Mg, Mo, Mn, Ni, S, Zn
	marginal chlorosis / death	B -- also Ca, Cl, Cu, K, Mg, Mo, Ni
	stunted / distorted blades	B -- also Cl, Cu, K, Mg, Mn, Mo, N, Ni, Zn
whole tree	increase pest effectiveness	B -- also Cl, K, Mg, Mn, Ni, Si

Boron is considered immobile among elements within a tree (immobile rank 6th).

symptom tissue location & age	element mobility inside tree	causal elemental deficiency
new tissues dominant	immobile	B -- also Ca, Co, Cu, Fe, Mn, Ni, S, Zn

At pH of 6.5 to 10.0, boron is poorly available or unavailable to trees. When toxic, boron has been cited as generating the following symptoms:

tree part	primary symptom	toxicity responsible
leaves	color -- chlorosis	B -- also Ca, Cl, Co, Cu, Mn, Ni
	marginal burn / scorch	B -- also Cl, Mn, Ni
	brown / death	B

Boron shares toxic and deficiency symptoms with many other essential elements. Proper identification of the cause for toxicity or deficiency symptoms must, at the least, involve tissue analysis for deficiencies and soil testing for toxicities.

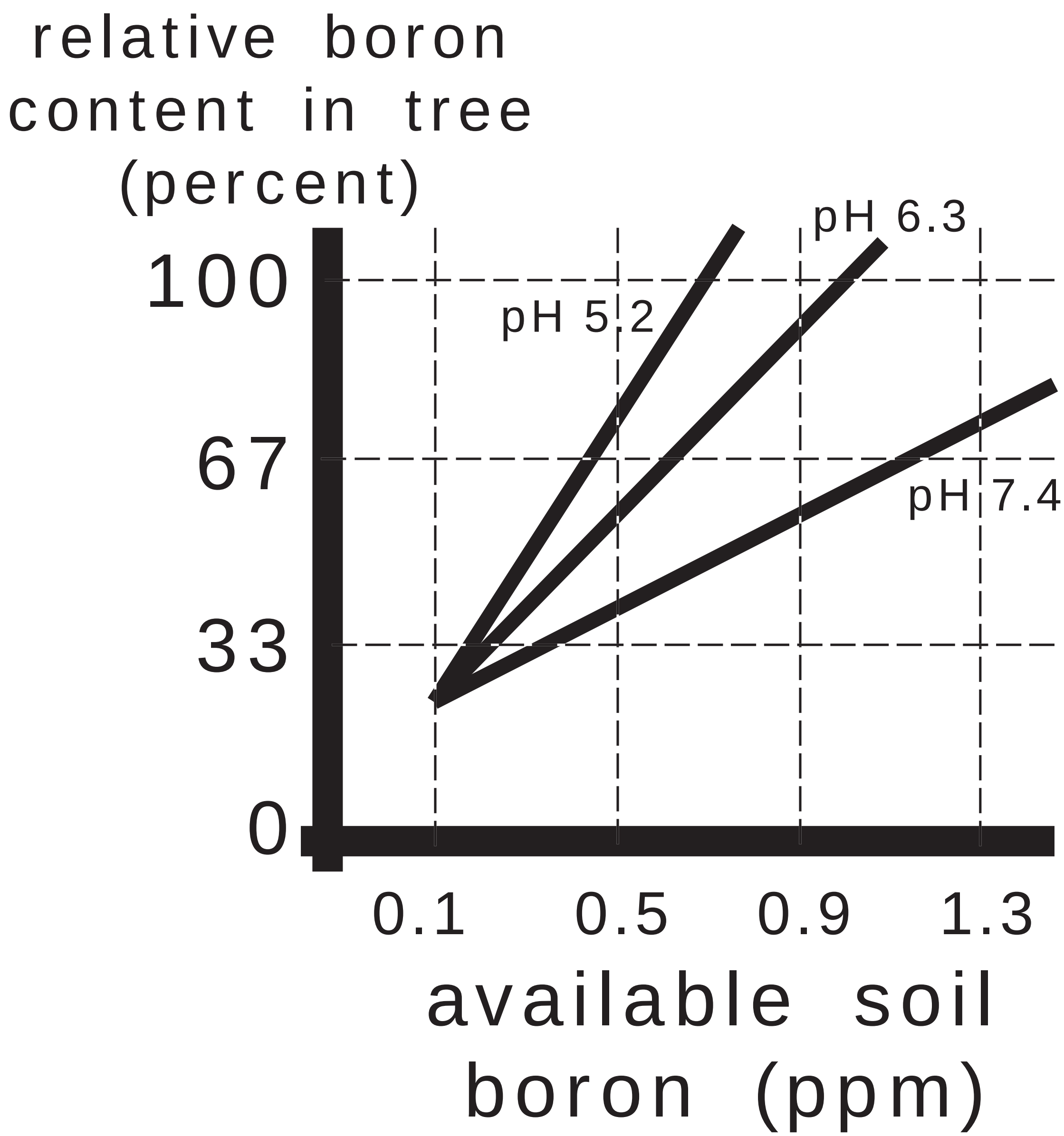

Figure 1: Estimated pH impacts on boron (B) concentrations in tree (from coarse-textured / sandy loam soil).