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Boron Accumulation in *Taxus media*[1]

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Abstract. Taxus media **Rehd. 'Anderson' were grown at 4 boron rates: 0.5, 5.0, 25.0 and 50.0 ppm using 2 media:4 pinebark:1 sand and 4 hardwood bark:1 sand. B toxicity symptoms developed when foliar B concentration was between 85-100 μg/g of dry tissue. Foliar symptoms of B toxicity were characterized by leaf-tip yellowing followed by leaf-tip necrosis and premature defoliation. Shoot and root growth were suppressed at the 50 ppm B application rate. B continued to accumulate in the foliage after the 2 higher rates of B were discontinued. Foliar concentration of Ca, Mn, Fe and Zn were lower when plants were grown with 25 and 50 ppm B when compared to plants grown with 0.5 and 5 ppm B.**

Boron toxicity in nursery crop production is generally associated with over fertilization with B fertilizers. A recent report (2), has shown that many commonly used nursery fertilizers contain considerable amounts of B. Although limited data is available on B toxicity in ornamental crops (1), values for toxic concentrations of B in the tissue are not available for woody ornamentals. Current recommendations for low, sufficient and high tissue levels of B for ornamentals are generally based on observation of grower samples (3).

The objective of this study was to establish a critical toxic concentration of B for 'Anderson' yew, and to determine the effect of B on plant mineral composition.

Uniform 2 year-old liners of 'Anderson' yew were potted into 3 liter plastic containers on November 30, 1978, in 2 different media; pinebark and sand (4:1 v/v) and hardwood bark and sand (4:1 v/v). Both media were amended according to current recommendations (3). These plants were grown in a greenhouse at about 26°C day/21° night. Incandescent lights were used to extend the photoperiod from 10 PM — 2 AM. Four weeks after potting, weekly fertilization was commenced using Peters water soluble fertilizer (20N—8.7P—16.7K) at the rate of 150 ppm N. Boron content of this fertilizer is 0.0068%. This frequency and rate of fertilization was continued throughout the study. On March 15, 1979, 4 treatment levels were initiated: 0.5, 5.0, 25.0 and 50.0 ppm B in the form of boric acid. Each week 250 ml of each respective treatment were applied. As a result of severe defoliation, treatments of 25.0 and 50.0 ppm B were not applied after June 19, 1979. Six, 12, and 24 weeks after the initial treatments, tissue samples were collected from the terminal 5 cm of growth. All tissue samples were analyzed at the end of the experiment by the Research Extension Analytical Laboratory (REAL) at the Ohio Agricultural Research and Development Center, Wooster. A randomized block experimental design was used with 4 replications of 6 plants each.

B toxicity symptoms were apparent on plants treated with 25 and 50 ppm B at the first sampling date. Foliar symptoms of B toxicity on *Taxus* were characterized by leaf-tip yellowing followed by leaf-tip necrosis and premature defoliation. With the highest rate of applied B, some leaftips were necrotic within 2 weeks. By June 19, plants grown in hardwood bark at the 2 higher B levels and plants grown in pinebark at the highest B level were severely defoliated. Additional new growth occurred when these treatments were discontinued. The lack of an expected difference in shoot growth between plants grown at 5 and 25 ppm B in the pinebark medium may have resulted from this additional growth. Shoot and root growth on plants grown in both media at the 50 ppm B level were suppressed (Table 1).

Table 1. Effects of boron and media on growth of *Taxus* media 'Anderson'.

B levels (ppm)	Shoot dry wt (g)		Root dry wt (g)	
	Hardwood bark	Pinebark	Hardwood bark	Pinebark
0.5	53	41	47	107
5.0	52	42	48	85
25.0	43	41	40	83
50.0	26	29	28	49
LSD 5%	6	4	8	17

Plants grown in both media at 25 ppm B, which had just begun to exhibit symptoms of B toxicity when tisssue samples were collected on April 25, had a B concentration of about 100 μg/g of dry tissue (Table 2). This would concur with reported B toxicity on grower samples with concentrations in excess of 100 μg/g. Plants receiving 0.5 and 5 ppm B did not exhibit B toxicity symptoms at any time during the experiment although B concentration at 5 ppm B was about 85 μg/g of dry tissue at the termination of the experiment. Perhaps the higher Ca concentration amerliorated the effects of excess B.

When B treatments were discontinued, B concentration in the new terminal growth was still in a toxic range. Since B is an immobile element (4), accumulation in the new growth must have been a result of B uptake from the media. Overfertilization with B may have long term effects on plant growth, and the normal watering will not leach out excess B. In our study, growth of 2 flushes were adversely affected on plants grown at 25 and 50 ppm B; the growth flush occurring during treatment application and the growth flush following the termination of B treatments. B continues to accumulate in the tissue well after a critical level of B is reached. The ability of plants to recover from B toxicity without effecting subsequent growth flushes may be dependent on the quantities of B accumulated in the tissue.

Combined analysis of the 2 media over 3 sampling dates showed that Ca, Fe, Mn and Zn foliage concentration were lower when plants were grown with 25 and 50 ppm B. Generally, it is accepted that Ca prevents micronutrients from being toxic (5, 6, 7); thus Ca status of the plant must be considered when determining phytotoxicity levels of micronutrients. Lower levels of Ca at the higher B rates may

Table 2. Boron content of *Taxus media* 'Anderson' grown at 4 boron levels in 2 bark:sand media (4:1 v/v) at 3 dates.

Boron level (ppm)	April 25		June 7		September 17	
	Hardwood bark	Pinebark	Hardwood bark	Pinebark	Hardwood bark	Pinebark
0.5	36	28	48	36	46	60
5.0	35	40	60	40	85	83
25.0[z]	96	100	301	253	168	107
50.0[z]	232	222	730	364	293	302
LSD 5% = 23.2						

[z]Treatments discontinued after June 19, 1979. September 17 data represented B accumulate from B in media from earlier treatments.

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have increased the susceptibility of these plants to B toxicity.

Comparison of the mineral element composition of plants grown in the 2 media showed that Ca, Mg and micronutrient tissue content was generally higher in the pinebark medium when compared to the hardwood bark medium (Table 3). N, P and K content was generally higher in plants grown with the hardwood bark medium.

Table 3. Mineral element composition of *Taxus* media 'Anderson' terminal 5 cm shoots grown at 4 boron levels.

Variable	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	Na (ppm)	Mn (ppm)	Fe (ppm)	B (ppm)	Cu (ppm)	Zn (ppm)	Al (ppm)
B (ppm)												
0.5	2.1	.23	2.1	.84	.19	30	130	39	48	6.4	66	20
5.0	2.1	.23	2.1	.77	.18	31	121	38	67	6.6	58	20
25.0	2.0	.23	2.1	.59	.18	34	92	31	171	6.5	50	9
50.0	2.0	.24	2.1	.66	.18	39	100	33	357	6.4	52	15
LSD 5%	NS	NS	NS	.05	NS	NS	9	3	16	NS	3	4
Media												
Hardwood bark	2.3	.27	2.2	.70	.14	32	94	32	164	6.0	42	11
Pinebark	1.9	.20	2.0	.75	.23	34	129	39	128	6.9	72	22
LSD 5%	0.3	.01	NS	.03	.04	NS	6	NS	12	0.2	3	2.8

Literature Cited

1. Francosis, L.E. and R.A. Clark. 1979. Boron tolerance of twenty-five ornamental shrub species. J. Amer. Soc. Hort. Sci. 104:319-322.
2. Gilliam, C.H. and E.M. Smith. 1980. Sources and symptoms of boron toxicity in container grown woody ornamentals. J. Arboriculture. 6:209-212.
3. Gilliam, C.H. and E.M. Smith. 1980. Fertilization of container grown nursery stock. Coop. Ext. Ser., Ohio State Univ. Bul. 658.
4. Kohl, H.C. and J.J. Oertli. 1961. Distribution of boron in leaves. Plant Physiol. 36:420-424.
5. Wallace, A., J.W. Cha, G.V. Alexander, and E.M. Romney. 1977. Calcium deficiency and $CaCO_3$ on micronutrient status of plants grown in solution culture. Commun. Soil Sci. & Plant Analysis 8:781-785.
6. Wallace, A., E. Forlich, and O.R. Lung. 1966. Calcium requirements of higher plants. Nature 209:634.
7. Wallace, A., and S.M. Soufi. 1975. Low and variable critical concentration of calcium in plant tissues. Commun. Soil Sci. & Plant Analysis 6:221-337.

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Factors Regulating Germination of Trifoliate Maple Seeds[1]

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Abstract. **Excised embryos from *Acer griseum* (Franch.) Pax., *A. mandshuricum* Maxim., *A. maximowiczianum* Mig. (*A. nikoense* Maxim.) and *A. triflorum* Kom. germinated within 21 days when incubated in a lighted environment on wick cultures moistened with a solution of 10 mg/liter gibberellic acid (GA_3). Cotyledon and epicotyl growth of *A. maximowiczianum* embryos were greatest when treated with GA_3. Embryos of *A. maximowiczianum* incubated with 6-benzylamino purine (BA) or 6-furfurylamino purine (kinetin) developed the longest roots while those treated with indoleacetic acid (IAA) or naphthaleneacetic acid (NAA) remained tightly coiled and dormant. Excised embryos incubated in darkness or intact seeds placed in all treatments failed to germinate. In *A. maximowiczianum* 3 sites of dormancy delay germination: pericarp, seed coat, and embryo.**

Acer griseum, A. mandshuricum, A. maximowiczianum (A. nikoense) and *A. triflorum* belong to the subsection *Trifoliata* (11). All species are characterized by short tree stature at maturity and autumn foliage of red, scarlet, or orange. A cinnamon-brown or yellow-brown flaking bark of *A. griseum* and *A. triflorum* respectively, further enchance the horticultural qualities of trifoliate maples, making them excellent ornamentals.

Samaras of the trifoliate maples, especially *A. griseum, A. maximowiczianum* and *A. triflorum*, have a ligneous pericarp which delays germination for several years (4,7). In addition, 2 to 5 years will elapse between good fruiting years with most fruits producing few seeds exhibiting double dormancy (7,16). They are not easily rooted from cuttings and must be grafted, but unfortunately need a rootstock of a similar species. Thus, trifoliate maples are rarely seen in cultivation.

Gibberellin or kinetin treatments have resulted in germination of dormant seeds of *Acer* (13,14). In *Acer pseudoplatanus* kinetin enhanced radicle elongation while gibberellin promoted cotyledon unrolling and growth (10). Results of experiments with seeds of *Acer* showed that breaking dormancy was dependent upon the concurrent reduction of ß-IAA (3). This paper reports the results of experiments conducted to determine the role of growth regulators, the seed coat, and light in controlling germination of trifoliate maples.

Fruits of *Acer griseum* and *A. maximowiczianum* were collected during October, 1979 from trees in the U.S. National Arboretum, Washington, D.C. *A. mandshuricum* and *A. triflorum* fruits were supplied by the Arnold Arboretum Jamaica Plain, Massachusetts. Samaras were stored in paper bags at 10°C in the dark.

Seeds were extracted from samaras by breaking the hard pericarp with pruning shears and a budding knife. Softening the seed coat in water at 25°C for 30 to 40 min facilitated embryo removal under a dissecting microscope. Seeds or embryos received treatments while being incubated on wick cultures which consisted of a folded 12.5 cm Whatman No. 2 filter paper inserted into a 25 x 150mm glass tube. The seeds or embryos were placed into an upper fold of the filter paper with the embryonic radicle pointing down.

Control and growth regulator solutions of auxins, cytokinins or gibberellic acid were prepared by adding 5 drops of 1N KOH to the crystals and diluted to volume with deionized water. Ten ml of solution were added to each culture before the tubes were capped. Cultures were incubated at 25°C for 21 days. Each treatment consisted of 10 replications. Germination was defined as expansion of the embryonic radicle, cotyledons, and plumules.

Experiment I. Naked embryos excised

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