SOURCES AND SYMPTOMS OF BORON TOXICITY IN CONTAINER GROWN WOODY ORNAMENTALS[1]

by C.H. Gilliam[2] and E.M. Smith

Abstract. Boron (B) toxicity is characterized by leaf tip yellowing and marginal chlorosis followed by leaf tip burning and premature leaf drop. Data showed that several common preplant media fertilizers are quite high in B. Boron toxicity is best avoided by proper pH balance and by avoiding micronutrient fertilizers with high levels of B.

Boron (B) toxicity of woody plants has primarily been associated with plants grown in the western United States and over fertilization with B fertilizer. Francois and Clark (2) evaluated the tolerance of 25 ornamental shrub species to B. They reported varying symptoms and tolerance to B depending on the species.

During the past year, several cases of boron toxicity have been identified in containerized nurseries producing woody ornamentals. These nurseries were not located in the same geographic regions. In all cases of B toxicity, symptoms became visible between mid-summer and late autumn. Boron is a relatively immobile element within the plant and moves primarily in the xylem.

Symptoms. The early symptoms of B toxicity on both Rhododendron and Taxus were characterized by leaf-tip yellowing (Fig. 1). This concurs with reported data on other crops (1,2,3). As the toxicity progressed, marginal chlorosis was observed with Rhododendron (Fig. 2), followed by tip burning and premature leaf drop. With Taxus, no marginal chlorosis developed. Leaf tips turned yellow, followed by tip burn. Often it appeared that the leaf tips or margins had been scorched or burned (Fig. 3). In some cases of severe toxicity, the tips turned brown almost immediately. These injury symptoms occurred because B is transported in the transpiration flow and accumulates in the leaf tips and margins as water is lost to the atmosphere (3,4).

If the B toxicity is not corrected, new growth the following season may be affected. Terminal growth is generally rosetted or twig dieback occurs (Fig. 4). Leaves are dwarfed, curled and arise from shortened internodes. Flower buds, if present, generally die with acute B toxicity.

Early stage symptoms of B toxicity are similar to those produced by numerous other conditions, overwatering, soluble salts, etc. As a result, the first step to correcting a potential B problem is to analyze foliar tissue to positively identify if B toxicity exists. Currently research is underway to establish B levels in the tissue which cause B toxicity, however, based on available data from samples taken from growers and some research data, approximately 80-100 ppm B seems to be a critical level. Boron levels above this range in the foliage result in toxicity symptoms while B levels below this range seem to result in normal growth. Further research is underway to determine more precisely critical B levels and the growth reductions with excess B.

Sources of boron. Most B toxicity problems in the nursery industry are caused by over fertilization with B fertilizers. The major source of B in a container medium is the micronutrient fertilizer. Seven micronutrient sources are presented in Table 1, and four of these have B levels of 1,000 ppm or higher. These sources alone will not generally produce B toxicity because the B becomes available over an extended period of time. Many of the other pre-plant mix ingredients contain B. For example, in Table 2 a number of common pre-plant ingredients are listed with the rate per cubic yard of medium, % B, and the grams of B per container. Clearly, some of the fertilizers are quite high in B. For example, one pine bark medium studied contained .25 ppm B, and Canadian peat contained approximately .06 ppm

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[2] Current address: Department of Horticulture, Auburn University, Auburn, Alabama 36830

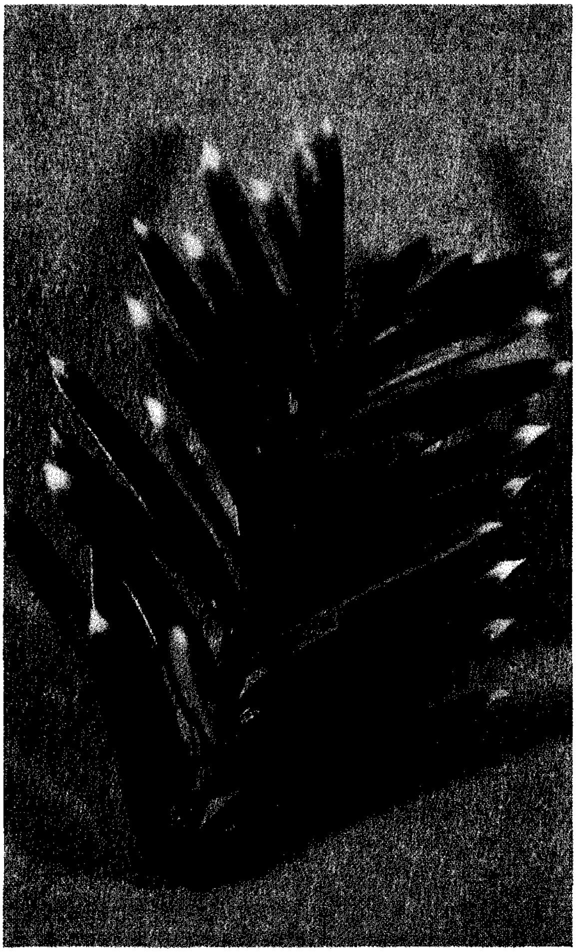

Fig. 1. Early symptoms of B toxicity on *Taxus media*.

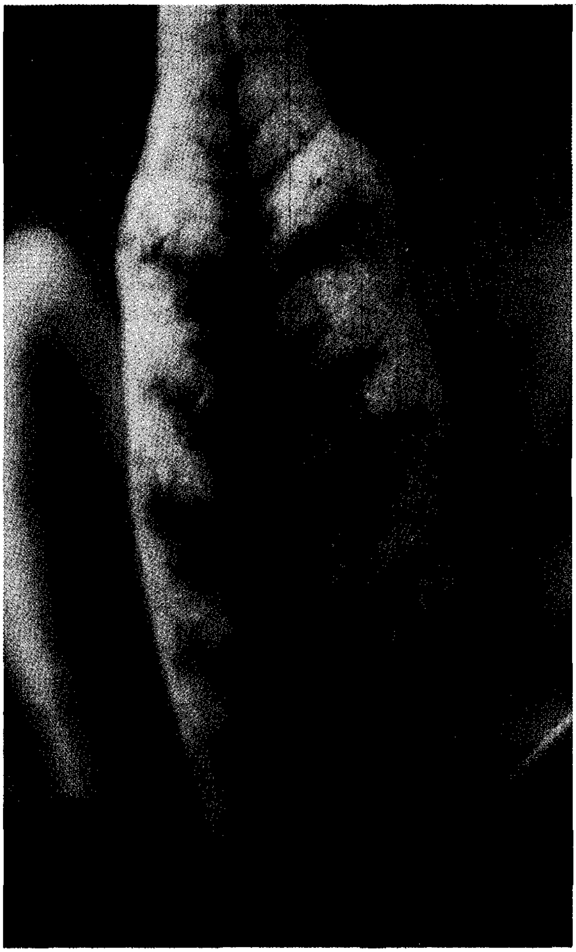

Fig. 2. Marginal chlorosis caused by B toxicity on *Rhododendron* × *Catawbiense*.

B. In many cases, total B may exceed 2 grams per container when all additives are considered.

Avoiding boron toxicity. One way to avoid B toxicity is to select a micronutrient fertilizer without B or one with low B levels. Our data show that adequate B is available as impurities in preplant medium ingredients (Table 2), and is not needed in the micronutrient fertilizer.

Boron toxicity may also be minimized by proper pH levels. Availability of B decreases as the pH increases. If B toxicity has been a problem, a pH range of 6.0-6.5 may adequately correct the problem. Most B toxicity problems occur when the pH is in the 4.5-5.5 range. As a result, we often see B toxicity on plants grown in this pH range (rhododendrons, azaleas, etc.).

To further complicate the problem of B toxicity, post plant fertilizers may contain B. For example, Peters standard fertilizer (20-20-20) has .0068% B, which means that when 200 ppm N is applied, approximately .68 ppm B is also applied. Some slow release fertilizers also contain B. Growers with B problems should request from the technical representative of the fertilizer company the data on B levels. We have found that many of the technical representatives were not aware of any B in their product. Government regulation for fertilizers only covers minimum levels in the fertilizer bag. Furthermore, the state agency which monitors fertilizers may not test for B, as is the situation in Ohio.

Previously it was mentioned that tissue analysis is necessary to confirm B toxicity. Even then, tissue analysis may not provide positive identification of B toxicity. Boron is very active in the soil and complexes with many other elements within the medium. Copper (Cu) is one element with which B complexes readily. As a result of the com-

Table 1. Mineral element composition of several micronutrient sources, in percent by weight of packaged product.

	Perk	*Esmigran*	*FTE 503*	*FTE 504*	*STEM*	*Lesco-Fe plus*	*Micro Max*
Boron*	0.02	0.02	3.0	3.8	1.45	0.05	0.1
Iron	3.7	2.0	18.0	14.0	7.5	5.0	12.0
Manganese	2.2	0.5	7.5	7.0	8.2	0.5	2.5
Zinc	0.7	1.0	0.05	7.0	4.5	1.0	1.0
Copper	0.2	0.3	3.0	7.0	3.2	0.5	0.5
Molybdenum	0.002	0.0006	0.2	0.07	0.046	—	0.005

*1% = 10,000 ppm

Fig. 3. Scorched or burned appearance of leaf-tip with the later stages of B toxicity on *Rhododendron* × *Catawbiense.*

Fig. 4. Dwarfed leaves arising from shortened internodes on Rhododendron as a result of B toxicity on *Rhododendron* X *Catawbiense.*

Table 2. Common sources and levels of B in fertilizers that are used in a pre-plant medium for container production.

source	*lbs./yd.*^{3}	*gms./container*	*% B*	*gms. B/2 gal. container*
Ureaformaldehyde	4.4*	14.98	0.00024**	0.0036
Iron sulfate	0.8	2.7	0.0642	0.1749
Gu 49 (micronutrient)	2.0	6.8	0.1950	1.3280
Dolomitic limestone	4.0	13.6	0.004	0.0545
Triple superphosphate	1.8	6.1	0.0328	0.2010
Gypsum	3.2	10.9	0.0140	0.1525
				1.9145

*Rate of fertilizer incorporated into the preplant medium.
**Samples were digested in 6N HCL for 4 hours at 90°C.

plex, Cu may often be low or deficient in the tissue sample where B toxicity exists. In fact, B toxicity may induce Cu deficiency. Also, zinc (Zn) may appear to be low in the tissue sample.

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Department of Horticulture
OARDC, Wooster, Ohio and
Ohio State University
Columbus, Ohio

ABSTRACTS

Hamilton, D.F. and S.R. Laakman. 1979. **How to diagnose plant problems in the nursery.** Am. Nurseryman 150(8): 10, 59, 62-69.

An incorrect diagnosis will lead to improper treatment, which may result in more extensive damage to the plant and expense. There are many factors that influence the health and performance of a plant and all of them should be considered in making a diagnosis. The following article is intended to be an aid in diagnosing plant problems in a nursery. The information can also be used for diagnosing problems in a landscape. A number of factors affect plant growth. Environmental conditions, soil conditions, chemicals, nursery management practices, availability of nourishment and container production materials all influence the growth of plants in the nursery.

Townsend, A.M. 1979. **An analysis of red maple characteristics.** Am. Nurseryman 150(9): 12-13, 66, 68, 70.

The large natural range of the red maple allows for great genetic diversity. This article reports on some of the significant findings that have been revealed to date. Wide variations in height, color, and form were found between seedlings from different geographic areas. The fastest growing trees were from the north central and east central seedlot groups. Most trees from the northern group grew slowly. Trees from the southern group also grew slowly, but this is probably due to winter injury rather than inherent growth rate. The trees in the west central group achieved average growth.