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# Treating Boron Toxicity in *Rhododendron catawbiense*[1]

**C. H. Gilliam,[2] E. M. Smith, S. M. Still, and W. J. Sheppard[3]**

*The Ohio State University, Columbus, OH 43210 and Ohio Agricultural Research and Development Center, Wooster, OH 44691*

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***Abstract.*** **Seven fertilizer treatments and a pruning treatment were evaluated for their effect on reducing symptom expression of B toxicity on spring growth of *Rhododendron catawbiense* Michx. 'Lees Dark Purple'. Pruning of tissue showing B toxicity was the best treatment based on the first growth flush; treatment with $CuSO_4$ + limewater was the best treatment based on the second growth flush.**

Previous research has shown B toxicity to be a problem with production of ornamental shrub species (1, 2). Most B toxicity problems in the nursery industry are caused by over fertilization with B fertilizers. The symptoms of B toxicity are leaf tip chlorosis followed by marginal chlorosis and tip necrosis. Effects may extend into the following season as a rosetting and/or twig dieback of new growth. These symptoms usually are expressed during the late summer months as transpiration rate increases. If B toxicity is not corrected, new growth the following season is affected (2). This study was designed to evaluate treatments with potential to reduce damage to spring growth of plants with B toxicity.

Plants of 'Lees Dark Purple' rhododendron with B toxicity confirmed by foliar analysis were selected on November 15, 1979 on the basis of tip chlorosis and necrosis on mature foliage. Seven fertilizer treatments (Table 1) were applied twice as a foliar application and/or soil drench on November 30, 1979 and January 3, 1980. The 8th treatment (pruning all damaged plant tissue) was performed on November 30, 1979. Greenhouse temperatures were maintained at about 26°C (day)/21° (night) with the natural photoperiod supplemented by incandescent light from 10 PM – 2 AM. The 8 treatments were replicated 3 times with 8 plants per treatment.

Data were collected on January 25 on leaf distortion, twig dieback and chlorosis using a visual rating scale from 1 (complete dieback, distortion or chlorosis) to 5 (no dieback, distortion or chlorosis). Leaf samples were collected at the same time, dried at 70°C for 48 hr and ground to pass a 40-mesh screen. Foliar samples were analyzed with an inductively coupled plasma spectrograph at the Ohio Agricultural Research and Development Center Research Extension Analytical Laboratory, Wooster. A visual rating was made at the end of the second growth flush in May.

Removal of damaged tissue by pruning resulted in plants with the least amount of damage on the first growth flush (Table 2). When leaf distortion, twig dieback, and chlorosis were evaluated collectively, a 3.5 rating was considered to be salable. Plants from the pruning treatment had normal growth of leaves and stems and an overall rating of 4.2. Since B moves in the xylem and accumulates in terminal tissue, removal of the damaged tissue may eliminate excess B from the plant.

$CuSO_4 \cdot 5\,H_2O$ + $Ca(OH)_2$ (limewater) and limewater alone also resulted in limited reductions in first growth flush damage. The beneficial effects of $CuSO_4$ + limewater may be due to the alleviation of B toxicity expression with high Cu levels (Table 2). Plants with higher Cu levels in the new foliage had lower B toxicity symptoms. It appears that pH may influence B movement and activity within the plant.

Our results suggest that high B affected spring growth prior to treatment initiation. Damage to incipient vegetative shoots in terminal regions prior to treatment initiation would explain the lack of initial response to applied treatments. The pruning treatment was effective due to removal of the terminal regions.

However, foliar B levels were within acceptable ranges (3) at the end of the first growth flush (Table 3). This indicates that B levels in the media may have been reduced through normal watering over a 6 month period. Earlier research (2), indicated that B is not easily leachable from the medium within a 2 month period; however, this does not preclude the occurrence of adequate leaching over a 6 month interval.

The $CuSO_4$ + limewater treatment was rated highest in limiting B toxicity expression in the second growth flush (Table 2). The next most effective treatments in decreasing order were pruning, $CuSO_4$ + $ZnSO_4$ + limewater, and limewater alone for the April evaluation; whereas for May, these treatments were equivalent.

Foliar analysis data confirmed the uptake of the applied Cu and Zn. Plants receiving

Table 1. Treatments applied to minimize B toxicity treatments 1–7 applied November 30, 1979 and January 3, 1980; treatment 8 on November 30, 1979.

| Treatments | Rate | Application method |
|---|---|---|
| $CuSO_4 \cdot 5\,H_2O$ + | 3.6g/liter | Spray |
| $Ca(OH)_2$ | 3.6g/liter | Drench |
| $ZnSO_4 \cdot 7\,H_2O$ + | 3.6g/liter | Spray |
| $Ca(OH)_2$ | 3.6g/liter | Drench |
| $CuSO_4 \cdot 5H_2O$ + | 3.6g/liter | Spray |
| $ZnSO_4 \cdot 7\,H_2O$ + | 3.6g/liter | |
| $Ca(OH)_2$ | 7.2g/liter | Drench |
| $CaSO_4 \cdot 2\,H_2O$ | 13g/6.5 liter container | Surface applied |
| $Ca(OH)_2$ | 3.6g/liter | Drench |
| P (phosphoric acid) | 50 ppm | Drench |
| P (phosphoric acid) | 100 ppm | Drench |
| Pruning of B-damaged tissue | ----- | ----- |

Table 2. Evaluation of 8 treatments on subsequent expression of B toxicity in rhododendron.

| | Rating of B toxicity symptoms[z] | | | Avg rating[y] | | |
|---|---|---|---|---|---|---|
| Treatments | Leaf distortion | Twig dieback | Chlorosis | 2 | 5 | 6 |
| $CuSO_4$ + limewater | 3.2 | 3.1 | 2.8 | 3.0 | 5.0 | 5.0 |
| $ZnSO_4$ + limewater | 1.8 | 3.2 | 2.2 | 2.4 | 2.7 | --- |
| $CuSO_4$ + $ZnSO_4$ + limewater | 2.3 | 2.3 | 2.1 | 2.2 | 3.3 | 3.7 |
| Gypsum | 2.5 | 2.2 | 2.0 | 2.2 | 2.3 | --- |
| $Ca(OH)_2$ (limewater) | 2.7 | 3.0 | 2.8 | 2.8 | 3.0 | 3.7 |
| 50 ppm P (phosphoric acid) | 1.9 | 2.9 | 2.0 | 2.3 | 2.7 | --- |
| 100 ppm P (phosphoric acid) | 2.3 | 2.9 | 1.8 | 2.3 | 2.3 | --- |
| Pruning | 4.3 | 4.3 | 3.9 | 4.2 | 4.3 | 3.7 |
| LSD 5% | 0.7 | 0.6 | 0.5 | 0.8 | --- | --- |

[z]Visual ratings were made on a 1–5 scale with 5 indicating no distortion, dieback, or chlorosis and 1 indicating complete distortion, dieback or chlorosis; 2 months after treatment application.

[y]Visual rating values were averaged 2, 5, and 6 months following initial treatments.

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[2]Current address: Department of Horticulture, Auburn University, AL 36849.

[3]Assistant Professor, Professor, Associate Professor and Agricultural Technician.

Table 3. Mineral element composition of rhododendron with B toxicity, 4 weeks following treatment.

| Treatments | Leaf concn (dry wt) P (%) | K (%) | Ca (%) | Mg (%) | Na (%) | Mn (ppm) | Fe (ppm) | B (ppm) | Cu (ppm) | Zn (ppm) | Al (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $CuSO_4$ + limewater[z] | .26 | 2.0 | .62 | .18 | 1.6 | 112 | 38 | 41 | 97 | 26 | 20 |
| $ZnSO_4$ + limewater | .29 | 2.3 | .64 | .20 | 2.1 | 119 | 33 | 49 | 2 | 117 | 16 |
| $CuSO_4$ + $ZnSO_4$ + limewater | .26 | 2.0 | .62 | .18 | 2.0 | 85 | 34 | 43 | 22 | 70 | 14 |
| Gypsum | .31 | 2.4 | .68 | .21 | 1.9 | 119 | 36 | 40 | 3 | 27 | 21 |
| $Ca(OH)_2$ (limewater) | .30 | 2.4 | .63 | .22 | 1.8 | 116 | 37 | 43 | 7 | 27 | 20 |
| 50 ppm P (phosphoric acid) | .28 | 2.2 | .71 | .20 | 2.2 | 134 | 34 | 50 | 3 | 23 | 20 |
| 100 ppm P (phosphoric acid) | .32 | 2.4 | .71 | .22 | 2.0 | 128 | 40 | 48 | 3 | 27 | 21 |
| Pruning | .32 | 2.2 | .64 | .23 | 1.6 | 131 | 40 | 50 | 3 | 28 | 19 |
| LSD 5% | NS | .15 | NS | .02 | NS | NS | NS | 4 | 19 | 18 | NS |

[z]Treatments were applied when spring flush shoots were about 5–8 cm in length.

$CuSO_4$ plus limewater had 32 times more Cu than plants not receiving Cu. Plants treated with $ZnSO_4$ plus limewater had 5 times more Zn than all other plants not treated with Zn. With the exception of $ZnSO_4$ plus limewater all plants treated with limewater or $CaSO_4 \cdot 2H_2O$ (gypsum) had less foliar B than plants treated with phosphoric acid or pruning.

Our data indicate that pruning of the mature foliage exhibiting B toxicity symptoms during the fall season and treating with $CuSO_4$ + limewater resulted in plants of salable quality the following spring. A drench of $Ca(OH)_2$ and addition of gypsum to the medium reduced B uptake.

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# Polyploidy in Evergreen Azaleas[1]


**J. Heursel**[2]

*Institute of Ornamental Plant Growing, B-9230-Melle, Belgium*

**R. De Roo**

*Government Plant Breeding Station, B-9220-Merelbeke, Belgium*



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***Abstract.*** **The chromosome number of 47 cultivars of *Rhododendron simsii* Planch. were all diploid ($2n = 26$) except 'Euratom' which was triploid ($3n = 39$). A number of *R. simsii* cultivars from China and Thailand, as well as *R. indicum* (L.) Sweet., *R. tamurae* (Makino) Masam., *R. keiskei* Miq., and *R. kiusianum* Makino were found to be diploid.**


The evergreen non-winterhardy azaleas which are grown as pot plants, are hybrids of *Rhododendron indicum* (L.) Sweet., *R. tamurae* and, principally, *R. simsii*. The Japanese azaleas used for forcing and as garden plants are descendants of *R. kaempferi* Planch., *R. kiusianum* Makino and *R sataense* Nakai. These species are indigenous to two centers of origin, viz., *R. simsii* to Southern China and the other species to Japan.

Although the efficiency of a breeding programme is strongly promoted by the knowledge of the occurrence of polyploidy in the genus, little research has as yet been undertaken for evergreen azaleas. Janaki Ammal et al. (3) investigated 360 of the 1,000 species of the genus *Rhododendron* but in their study of *R. simsii R. eriocarpum* Nakai was used. According to Ohwi (5) *R. eriocarpum* and *R. tamurae* are synonymous. This species resembles *R. indicum* but is markedly different from *R. simsii*. Consequently, some doubt exists whether *R. simsii* has actually been investigated, as it was difficult to obtain plants from China in 1950. This means that *R. eriocarpum* was probably studied instead of *R. simsii*. The specimen of *R. simsii* in our study came from the National Forestry Institute in Nanking through the good offices of the National Arboretum in Washington, D.C. who were also able to procure for us *R. tamurae* from Kurio, Japan, and *R. indicum* from Kosugedani, Yakushima. Another specimen of *R. simsii* came from Thailand, having been collected by Valder (7).

Pryor and Frazier (6) observed that the *R. simsii* cultivar 'Red Wing' was triploid. They believed 'Red Wing' to have been derived from 'Willem van Oranje' x 'Hexe'. 'Hexe' proved to be diploid but the ploidy of 'Willem van Oranje' was unknown as it was no longer found in the U.S.

A study of the ploidy of *R. simsii* cultivars and related species seemed justified because of the great commercial value of the evergreen azaleas in western Europe. Besides the above mentioned species and cultivars, many *R. simsii* cultivars were examined which came from a collection of 231 cultivars belonging to the Institute of Ornamental Plant Growing at Melle, described by Heursel (1). Samples were taken from flowering plants to check the authenticity of the cultivars.

Young root tips or apical meristems were fixed in 1:3 glacial acetic acid alcohol for 24 hr and then hydrolyzed in 1N HCl and stained in 1% orcein in 45% acetic acid. Chromosome counts on squash preparations were readily made using the same stain.

Eight Rhododendron species and 47 cultivars were examined. *Rhododendron simsii* cultivars were: 'Adventsglocke', 'Ambrosiana', 'Apollo', 'Charles Encke', 'Dame Melanie', 'Dirk Bosch', 'Doctor Bergmann Feu', 'Eclaireur', 'Etoile de Belgique', 'Friedhelm Scherrer', 'Gloire de Claude Goyet', 'Hexe', 'Josiane Maeseele', 'Karl Glaser', 'Knut Erwén', 'Leopold Astrid', 'Madame Auguste Haerens', 'Mevrouw Jozef Heursel', 'Milda Glaser', 'Perle de Noisy', 'Pink Dream', 'Prinses Josephine Charlotte', 'Professor Wolters', 'Prosper Van den Dael', 'Red Wing', 'Reinhold Ambrosius', 'Vervaeneana alba', 'Violacea' and 'Willem van Oranje'. All were diploid.

The diploid status of 'Red Wing' was surprising, and contrary to the findings of Pryor and Frazier (6).

In Belgium, the cross 'Apollo' x 'Hexe' produced the cultivar 'Euratom', which is triploid ($2n = 39$). Both parents are diploid. 'Casablanca tetra', imported from the U.S., is a tetraploid ($2n = 52$).

About 55% of the *R. simsii* assortment are mutants, containing not only flower-color sports but also flowers with strongly frilled edges and altered leaf shapes. Changes of ploidy level were checked to see if they could possibly be associated with the occurrence of sports.

The whole range of the Schäme series was investigated, starting with the original cultivar 'Paul Schäme' and continuing with 'Doberlug', 'Dresden', 'Eri', 'Jan Bier', 'Madame Bourlard', 'Madame Marcel De Paepe', 'Max Schäme', 'Prinses Beatrix', 'Schäme alba', 'Schäme Frisee', 'Schäme saumona' and 'Werner Muckel'. All cultivars are diploid so no association could be detected between ploidy level and the appearance of sports.

*R. kiusianum* 'Myoken', a variation col-


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