Final Report to
The Agricultural Research Foundation
and the
Nursery Regulatory Committee

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Project Title: Determining the cause of marginal chlorosis in boxwood

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The objective of this research is to determine the cause of marginal chlorosis in boxwood, then develop production recommendations to prevent the chlorosis.

Materials and methods

Three potted experiments were conducted along with one survey experiment. The same substrate was used for all three potted experiments and was composed of 75% bark, 15% pumice and 10% peat moss by volume. This mix included a fertilizer starter charger, buffering materials, trace elements, and wetting agent. All the plants were irrigated twice a day for a total of 1.2 cm water through overhead irrigation.

Experiment 1. The objective of experiment 1 was to determine the influence of lime rate and nitrogen form on growth and occurrence of marginal chlorosis in boxwood. 'Green Mountain' boxwood liners were planted on March 29, 2005, in 1-gallon pots and placed in a retractable roof greenhouse. At planting, boxwood were approximately 15.8 cm tall and 12.8 cm wide. The roof of this house remained open throughout most of the summer. The treatment design was a 4x4 factorial with four lime rates and four nitrogen sources. Bark was amended with 0, 10, 20, or 40 lb/yd^3 dolomite lime. Plants were fertilized two times each week with ammonium sulfate, ammonium nitrate, calcium nitrate, or potassium nitrate at a rate of 300 ppm N. Twelve single pot replications of each treatment combination were arranged in a completely randomized design. On May 5, liquid fertilizer applications were terminated and all pots were uniformly topdressed with 14 g Osmocote 18-6-12. Data was collected July 29 and included a random sampling of plants to measure growth index, percent of leaves with chlorosis, and foliar tissue nutrient concentrations.

Experiment 2. The objective of experiment 2 was to determine the influence of light quantity and fertilizer type on growth and occurrence of marginal chlorosis in boxwood. 'Green Mountain' boxwood liners were planted on March 21 in one-gallon containers and placed in full sun or 50 % shade. The treatment design was a 5x3x2 factorial with five fertilizer types each applied at three different rates, placed in either sun or shade. A non treated control group was also maintained in sun and shade. Calcium carbonate and calcium sulfate were incorporated into the bark. Calcium nitrate, potassium nitrate, and ammonium sulfate were topdressed seven times over two months (once every two weeks). Six single pot replication of each treatment were arranged in a completely randomized design. Substrate pH was measured March 31 and April 18 by the pour through technique. On July 11 plants were rated for percent of leaves with chlorosis. On July 29 a random sampling of plants were collected to measure growth index, percent leaves with chlorosis, and foliar tissue samples.

Experiment 3. The objective of experiment 3 was to determine the influence of nitrogen forms on growth and occurrence of marginal chlorosis in boxwood. 'Green Mountain' boxwood and common boxwood (*Buxus sempervirens*) were planted on March 24 in 3-gallon containers with course bark and placed in the shade. At planting, 'Green mountain' boxwood were approximately 22 cm tall and 15.8 cm wide; common boxwood were approximately 15.2 cm tall and 11.6 cm wide. Treatments included four different nitrogen sources. Plants were fertilized two times each week with ammonium sulfate, ammonium nitrate, calcium nitrate, and potassium nitrate at a rate of 300 ppm N. Seven single pot replication of 'Green Mountain' boxwood and six of common boxwood were arrange in a completely randomize design by species. On July 25, liquid fertilizer application were terminated. Data was collected July 29 and included a random sampling of plants to measure growth index, percent of leaves with chlorosis, and foliar tissue samples.

On September 6 percent of leaves with chlorosis were measured in all experiments.

Experiment 4. Eighteen samples were collected from 7 sites at 2 different nurseries. Nine samples were collected from common boxwood growing in field soil, of which all samples were documented as being free from chlorosis. Three samples were collected from container-grown liners at the same nursery. These samples displayed chlorosis symptoms. Six samples were collected from a separate nursery, all of which were field grown common boxwood that displayed symptoms.

Results and Discussion.

Experiment 1. Data shows that plants which were planted in bark without lime have the highest percentage of leaves with chlorosis. Research by Walden and Epelman (1988) showed that boxwood growth was primarily depend on nitrogen form, and root and shoot weight were increased with increasing lime rate. However, our experiment indicates that nitrogen form has no effect on boxwood chlorosis. Minimal chlorosis was observed in plants which received additional 10 lb/yd^3 amount of lime regardless of nitrogen form applied. But when lime rate was increased to 20 lb/yd^3 chlorosis also increased. Correlation between marginal chlorosis and presence of nitrogen, phosphorus, potassium and magnesium in foliar tissue was observed, but correlations were weak.

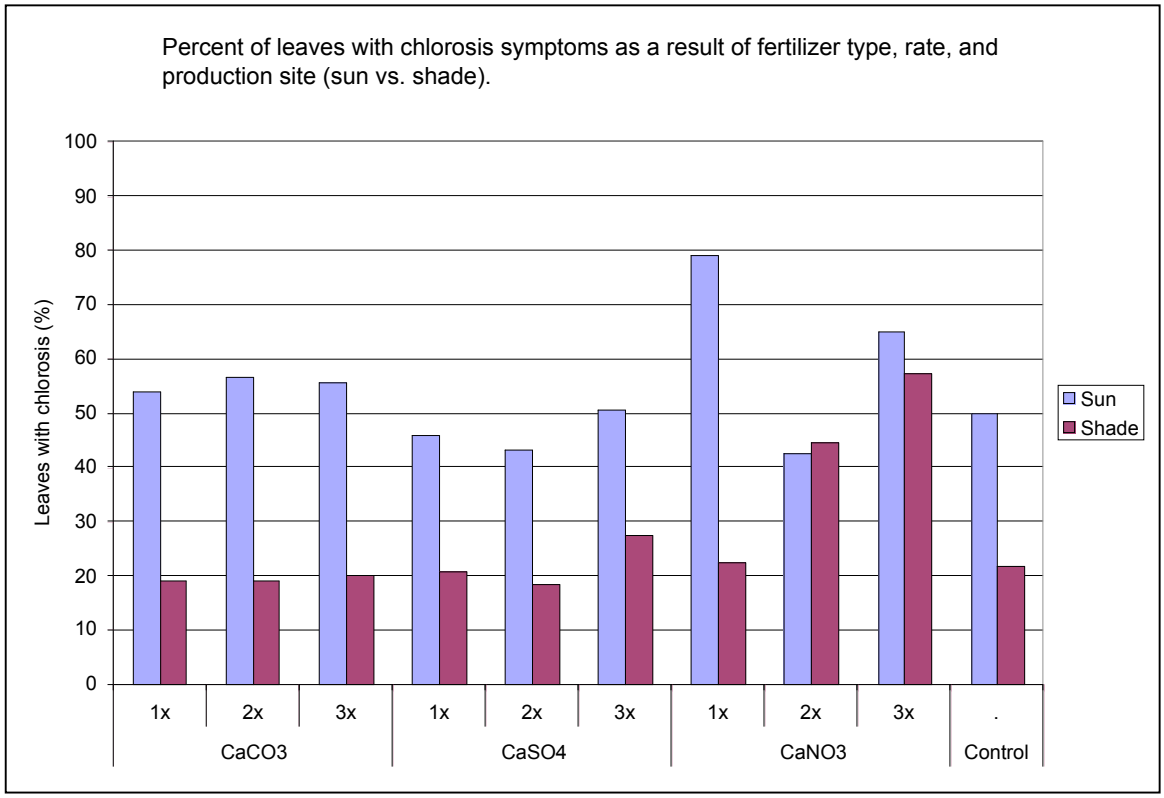
Experiment 2. Plants in the shade had a lower percentage of leaves with chlorosis compared to the group in the sun. None of the fertilizer amendments reduced marginal chlorosis compared to non-treated controls, although additions of calcium nitrate, potassium nitrate, and ammonium sulfate made the conditions worse.

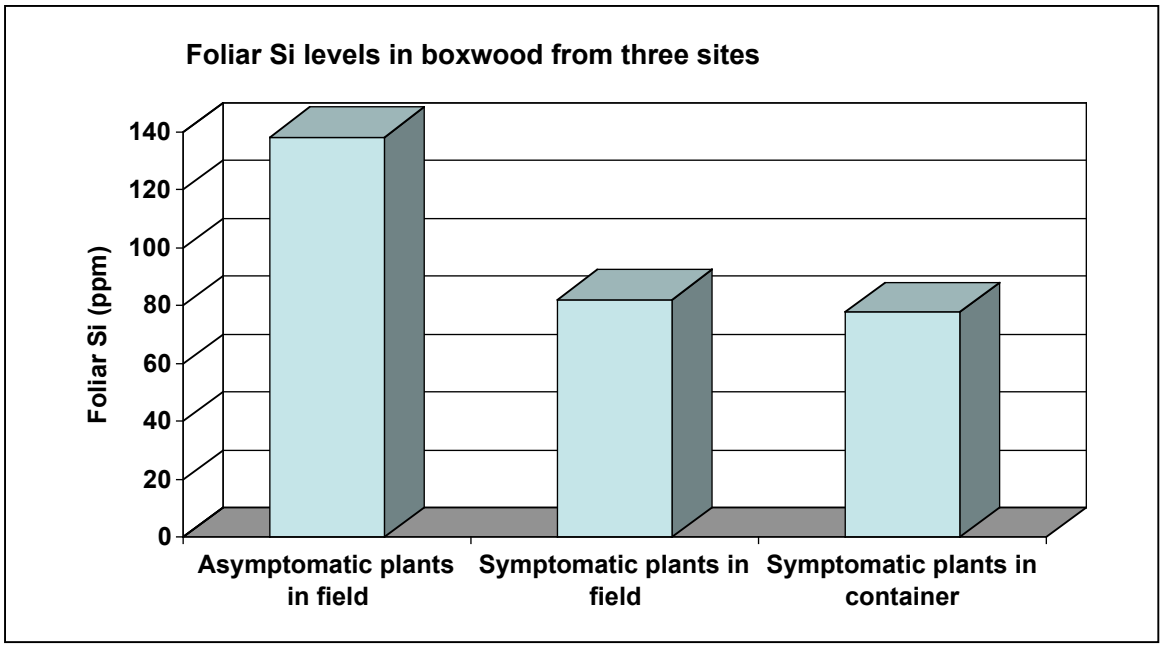
Experiment 3. Applying different forms of nitrogen to boxwood foliage did not improve growth or reduce the occurrence of chlorosis. The highest percentage leaves with chlorosis was observed in plants fertilized with potassium nitrate, which also caused a foliar necrosis. This agrees with research by Hefley (1979) who indicated that elevated levels of potassium seem to be detrimental to boxwood growth.

Experiment 4. Using tissue analyses to identify deficient or toxic nutrients in boxwood foliage is difficult. We were unable to find plants completely free of symptoms until late in the summer when during a chance visit to a local nursery we observed 3 independent fields completely symptom free. Interestingly, their liner stock in containers were symptomatic but crops in the field were not. We collected foliar tissue samples from boxwood at this nursery's fields, their symptomatic container stock, and another nursery with field-grown plants that were very symptomatic. Tissue analyses indicate the only difference between symptomatic plants and symptom-free plants were levels of foliar silicon (Si) and barium (Ba). We analyzed 18 samples in this trial (9 from symptom free field plants, 3 from symptomatic container stock, and 6 from symptomatic field plants), and presence or lack of Si and Ba in foliage was consistent in asymptomatic and symptomatic plants, respectively. After conversations with a local nurseryman familiar with these obscure elements in plant systems, we believe Si may be the critical element. This is not enough to prove the role of Si in marginal chlorosis, but it is hard to dismiss. We will conduct more tissue analyses on field-collected samples and do a simple rate study to see if applied Si will alleviate marginal chlorosis in containers.

Literature cited

1. Hefley W. M. 1979. Growth and foliar accumulation of mineral nutrient elements by Buxus sempervirens L. as affected by hydroponic nutrient level, soil type, soil pH and source of nitrogen. Dissertation.
2. Walden,R. F. and G. Epelman . 1988. Influence of liming rate on growth of Japanese boxwood in pine bark media. SNA Research conference: page numbers 52-57.


Percent of leaves with chlorosis symptoms as a result of fertilizer type, rate, and production site (sun vs. shade).
Leaves with chlorosis (%)
100
90
80
70
60
50
40
30
20
10
0
1x
2x
3x
1x
2x
3x
1x
2x
3x
.
CaCO3
CaSO4
CaNO3
Control
Sun
Shade


Foliar Si levels in boxwood from three sites
Foliar Si (ppm)
140
120
100
80
60
40
20
0
Asymptomatic plants in field
Symptomatic plants in field
Symptomatic plants in container