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Response of *Loropetalum chinense* var. *rubrum* ‘Ruby’ to Foliar Applications of Micronutrient Fertilizers and Miticide¹

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Abstract

Loropetalum chinense (also called Chinese Fringe-bush or Chinese Witch Hazel) is commonly used in the Florida landscapes. However, in recent years, there have been increasing reports and complaints of unexplained decline throughout Central Florida. The objective of this study was to evaluate the growth and quality response of declining *L. chinense* plants to foliar micronutrient and miticide applications. *L. chinense* ‘Ruby’ plants exhibiting significant decline symptoms were treated with eight foliar fertilizer treatments (High Cu, Low Cu, Kocide® 2000 [copper hydroxide], B, Mn, Zn, and Peters S.T.E.M.) and half of the plants also received two treatments of GardenTech Sevin Concentrate Bug Killer® (carbaryl, 22.5% AI). Plant growth was not influenced by miticide or fertilizer treatments. However, plants sprayed with Cu (i.e., Cu high, Cu low, and Kocide) had quality ratings, at 4 and 8 weeks after treatment, that were significantly higher than plants treated with other foliar fertilizers. Additionally, results indicated that there was no fertilizer treatment effect on mite populations. Failure of the miticide to enhance plant quality ratings, suggested that eriophyid mites were not associated with decline symptoms. The quality of declining landscape plantings of *L. chinense* ‘Ruby’ can be improved with the application of foliar Cu sprays.

Index words: copper, zinc, boron, manganese, eriophyid mites, production.

Significance to the Nursery Industry

Loropetalum chinense is a woody plant used frequently in landscapes of the southeastern United States. Widespread decline of several cultivars (‘Ruby’, ‘Suzanne’, and ‘Sizzling Pink’) following installation into the landscape has the potential to have significant economic impact on landscape maintenance companies. These companies may be required to replace declining plants at their expense. In addition, widespread decline of these plants in the landscape may result in the use of different plants where *L. chinense* would have been planted, despite the availability of cultivars that are not susceptible to decline (e.g. Burgundy, Plum). Replacement of *L. chinense* with other woody species may leave nurseries with excess *L. chinense*. This research presents management strategies to reduce the symptoms of decline for *L. chinense* ‘Ruby’.

Introduction

Loropetalum chinense (also called Chinese Fringe-bush or Chinese Witch Hazel) is a woody ornamental plant commonly used in landscapes throughout the southeastern United States. *L. chinense* is native to China, Japan and the Himalayas. Several cultivars with variable foliage, flower color and growth habit are available (2). The cultivar ‘Ruby’ has been a popular choice in Florida landscapes because of its attractive burgundy foliage and pink flowers and its smaller and more

compact size, growing up to 4–6 ft high and wide compared to an average 8–10 ft for other cultivars (1).

L. chinense has long been considered a low maintenance landscape plant with only occasional insect or disease problems (2, 10). However, in recent years, there have been increasing reports and complaints of unexplained decline of *L. chinense* ‘Ruby’ in Central Florida landscapes (3). The first reports of decline occurred in the late 1990s and were from nurseries in Georgia and Florida that were growing the ‘Ruby’, ‘Suzanne’, or ‘Sizzling Pink’ cultivars in pine bark substrate in containers (6). The decline was termed ‘little-leaf’ disorder and symptoms included shortened internodes, cupped of leaves, darkened older leaves, and decreased leaf size (6). Currently, there have been no known reports of decline in *L. chinense* ‘Burgundy’ or ‘Plum’ in Florida.

Eriophyid mites were originally thought to be the cause of ‘little-leaf’ disorder (3). As a result, it was suggested that plants be sprayed every week to 10 days during flushes of new growth to control eriophyid mites using a rotation of carbaryl, abamectin and dimethoate (3). However, Ruter (6) found that foliar applications of Cu were able to relieve the symptoms on *L. chinense* ‘Suzanne’ plants growing in #5 containers, suggesting that a Cu deficiency may be a cause of ‘little-leaf’ disorder in *L. chinense*. The objective of this study was to evaluate the growth and quality response of declining *L. chinense* plants to foliar micronutrient and miticide applications.

Materials and Methods

In order to identify the potential cause for *L. chinense* decline in the landscape, composite plant tissue samples were collected from declining plants in three landscapes in Orange County, FL. Composite tissue samples were analyzed for Fe, Mn, B, Cu, Zn, and Mo using the University of Florida/IFAS digestion procedure for plant tissue (5). Plants were also inspected for the presence of eriophyid mites using a 10× hand lens.

L. chinense ‘Ruby’ plants in #3 pots (11.4 liter) exhibiting significant symptoms of decline were donated to the Univer-

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Table 1. Concentrations of trace elements in foliar micronutrient fertilizer treatments to container-grown *L. chinense*.

Treatment	Cu	Zn	Mn	B	Mo	Fe
	mg·L ⁻¹					
Cu-low	632	— ^z	—	—	—	—
Cu-high	1272	—	—	—	—	—
Kocide	6300	—	—	—	—	—
Zn	—	1312	—	—	—	—
Mn	—	—	740	—	—	—
B	—	—	—	88.0	—	—
Peter's S.T.E.M.	19.2	27.2	48.0	8.0	0.4	45.2
Control	—	—	—	—	—	—

^z— indicates that the micronutrient was not present.

sity of Florida Mid-Florida Research and Education Center (Apopka, FL) by Valley Crest Landscape Maintenance Co. (Sanford, FL). Plants were arranged in a completely randomized design with three plants per replication and grown in a nursery area on black weed cloth. Plants were irrigated by overhead sprinklers as needed.

Based on results of initial plant tissue analysis, eight fertilizer treatments were applied as a foliar spray to the shoots of *L. chinense* 'Ruby' plants. The fertilizer treatments were as follows: no fertilizer applied [control]; 2.40 g·liter⁻¹ copper (II) sulfate pentahydrate (Fisher Scientific, Pittsburgh, PA) + 1.3 g·liter⁻¹ calcium hydroxide (Fisher Scientific, Pittsburgh, PA) [Cu-high]; 6.0 g·liter⁻¹ copper (II) sulfate pentahydrate (Fisher Scientific, Pittsburgh, PA) + 3.2 g·liter⁻¹ calcium hydroxide [Cu-low]; 18.0 g·liter⁻¹ Kocide® 2000 fungicide (copper hydroxide, 53.8% by weight; E.I. du Pont de Nemours and Company, Wilmington, DE) [Kocide]; 3.60 g·liter⁻¹ manganese sulfate (Fisher Scientific, Pittsburgh, PA) + 0.25 g·liter⁻¹ calcium hydroxide [Mn]; 3.60 g·liter⁻¹ zinc sulfate heptahydrate (Fisher Scientific, Pittsburgh, PA) + 1.44 g·liter⁻¹ calcium hydroxide [Zn]; 0.80 g·liter⁻¹ sodium pentaborate (Fisher Scientific, Pittsburgh, PA) [B]; and 0.6 g·liter⁻¹ 0N-0P-0K-13S-1.35B-2.3Cu-7.5Fe-8Mn-0.04Mo-4.5Zn micronutrient fertilizer (Peter's S.T.E.M., Scotts Co., Maryville, OH) [Peter's S.T.E.M.]. To prevent foliar damage from the application of Cu, Mn, and Zn fertilizer treatments, lime was added to adjust the solution pH. Plants shoots were thoroughly sprayed once (to drip) with 250 ml of each fertilizer solution. Table 1 shows the concentrations of each micronutrient added per plant. In addition to foliar micronutrient fertilizers, the fertilizer treatments were split and half of the plants received two treatments of GardenTech Sevin Concentrate Bug Killer® (carbaryl, 22.5% AI; GardenTech, Lexington, KY) at the recommended label rate (9.76 ml·liter⁻¹). The remaining plants were sprayed with 250 mL water to represent a blank miticide treatment (no miticide treatment).

Plant growth measurements were taken on all plants at time of treatment with miticide and fertilizers and then every 2 weeks for 8 weeks following initial treatment. Growth index (GI) was used as a quantitative indicator of plant growth rate and to compare size of the plants grown under different fertilization and miticide treatments. Growth index for each plant was calculated as: $GI (m^3) = H \times W1 \times W2 [1]$, where H is the plant height (m), W1 is the widest width of the plant, and W2 is the width perpendicular to the widest width (8). In addition to GI, plant quality and mite damage were visually rated at 4 and 8 weeks after treatment. Quality

ratings were based on a 1–5 scale with the following rating system: 5 (dense, good plant quality/no mite damage) to 1 (very poor plant quality/extreme mite damage). A composite plant tissue sample was collected from each group of plants receiving the miticide and fertilizer treatment combinations. Plant tissue samples were collected at 11 weeks after treatment to ensure that tissue concentrations were not affected by fertilizer residues. Plant tissue samples were analyzed for Fe, Mn, B, Cu, Zn, and Mo using the University of Florida/IFAS digestion procedure for plant tissue (5).

The experiment was conducted as a completely randomized factorial design with fertilizer and miticide as fixed treatments. Each fertilizer-miticide treatment combination was replicated three times. Growth data were analyzed with SAS statistical software (7) utilizing the PROC MIXED procedure with time of measurement as a repeated measure. Due to non-normal distribution, plant tissue data and quality ratings were analyzed using the non-parametric procedure outlined in Shah and Madden (9). Plant tissue data and quality rankings were first ranked using the PROC RANK procedure; the ranks were then used in PROC MIXED to calculate the ANOVA-type statistic, which was used to test the null hypothesis of no miticide or fertilizer treatment effect. Results showed that plants treated with carbaryl had significantly lower mite populations than non-treated plants; however mite populations had no effect on plant growth or quality. Additionally, results indicated that there was no fertilizer treatment effect on mite populations. Results also showed no miticide treatment effect or miticide × fertilizer interaction on plant quality or plant tissue micronutrient content (ANOVA F-value = 1.14, df = 1, $p = 0.2861$). Therefore, miticide was removed from the statistical model to allow the error terms to be pooled. Median values are reported for plant tissue nutrient contents in the text because of non-normal distributions. Tables and graphs are presented in the original scale.

Results and Discussion

Average published micronutrient tissue concentrations for *L. chinense* 'Burgundy' were reported as 62, 37, 46, 7, 22, and 0.59 mg·kg⁻¹ for Fe, Mn, B, Cu, Zn, and Mo, respectively (4). Bulk tissue samples for *L. chinense* 'Ruby' exhibiting symptoms of decline in three Orange County, Florida landscapes averaged 40 ± 19 , 13 ± 6 , 27 ± 8 , 5 ± 1 , 14 ± 7 , and < 0.00 mg·kg⁻¹ for Fe, Mn, B, Cu, Zn, and Mo, respectively. These data suggested a potential micronutrient deficiency. Eriophyid mites were also identified on declining plants growing in these landscapes.

Plant growth was not significantly affected by miticide (F-value = 0.90; $df = 36$; $p = 0.23$) or fertilizer treatments (F-value = 0.90; $df = 36$; $p = 0.53$) during this study. Prior to treatment with fertilizers or miticide, the plant quality rating for all 180 plants was 1 (very poor). Symptoms of decline were obvious and included cupping and pitting of new leaves, leaf necrosis and leaf drop. Treatment with carbaryl significantly reduced the mite populations compared to non-treated plants; however mite populations had no effect on plant growth or quality. Results also indicated that there was no fertilizer treatment effect on mite populations. Additionally, no miticide effect on plant quality ratings was found at 4 and 8 weeks after treatment, suggesting that eriophyid mites were not associated with plant decline. There was, however, a significant fertilizer effect on plant

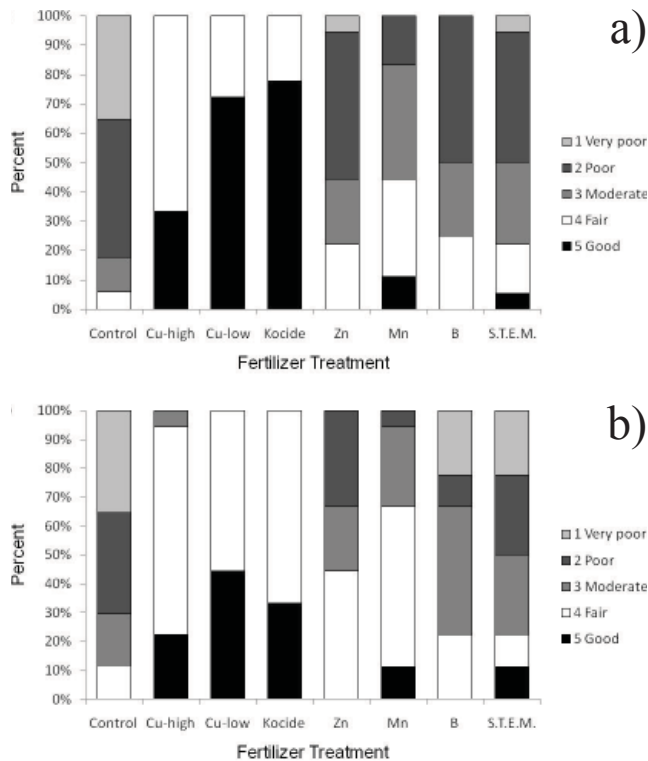


Fig. 1. Percentage of 18 plants receiving each fertilizer treatment that received a given rank on a plant quality scale of 1 to 5 at a) 4 and b) 8 weeks after treatment.

quality at 4 and 8 weeks after treatment (Fig. 1). All plants sprayed with Cu (i.e., Cu high, Cu low, and Kocide) had significantly higher plant quality ratings ($p < 0.001$) than plants treated with other foliar fertilizers. Foliar Zn sprays also led to plants with significantly higher quality ratings ($p < 0.001$) than plants sprayed with Mn, B, Peter's S.T.E.M. or non-treated plants. In addition, *L. chinense* that were treated with any fertilizer had quality ratings that were higher ($p < 0.01$) than plants that received no fertilizer. In contrast to our results, Ruter (6) reported that container grown *L. chinense* 'Suzanne' plants responded to foliar Cu treatments, but not foliar Zn treatments. Despite the presence of Cu in the Peter's S.T.E.M., it did not perform as well as the other Cu treatments due to the relatively small amount of Cu applied to each plant when sprayed with Peter's S.T.E.M. compared to the other Cu fertilizers (19.2 mg Cu-liter⁻¹ vs. 632–6300 mg Cu-L⁻¹, respectively; Table 1).

The miticide had no effect on plant tissue concentrations of Cu, Mn, Zn, and B ($p = 0.51, 0.41, 0.99$, and 0.65 , respectively). Foliar fertilizer treatments, however, did have a significant effect on plant tissue concentrations of Cu, Mn, and Zn ($p < 0.01$ for all micronutrients) (Fig. 2). For example, tissue concentrations of Zn (or Mn) were significantly higher for plants sprayed with Zn (or Mn) fertilizers compared with plants receiving the other foliar fertilizers (Fig. 2). Tissue concentrations of Cu were significantly higher for plants receiving high and low applications of CuSO₄ than for plants receiving B, Zn, or no fertilizer. Concentrations of Cu in plant tissue treated with Kocide, which contains significant amounts of Cu as copper hydroxide (Table 1),

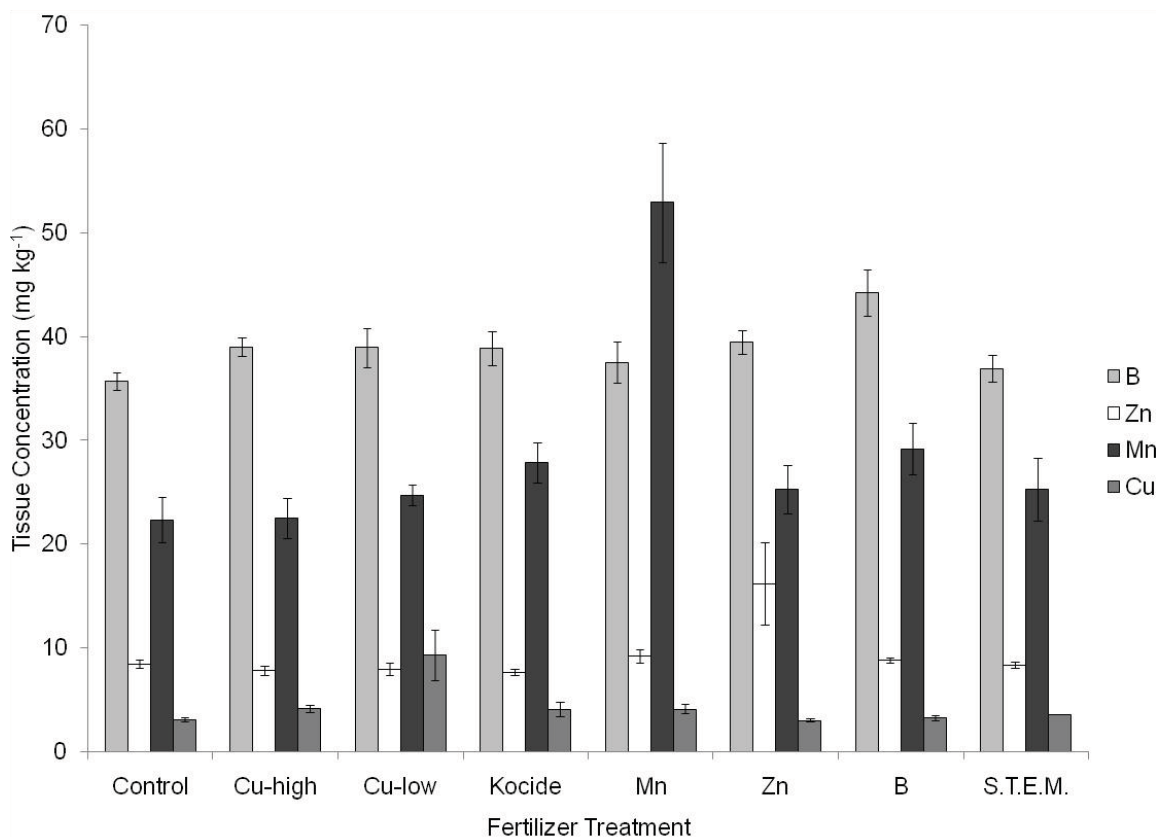


Fig. 2. Mean micronutrient concentrations in *L. chinense* tissue at 11 weeks after application of foliar fertilizer treatments. Error bars represent standard error.

were significantly lower than plants treated with copper sulfate. This is likely due to the high solubility of copper sulfate as compared to other Cu compounds. Furthermore, Cu tissue concentrations for plants receiving Kocide, Mn, Peter's S.T.E.M., B, Zn or no fertilizer were not significantly different. Boron tissue concentrations, however, were unaffected by application of foliar B. Only plants sprayed with Mn, Peter's S.T.E.M., or no fertilizer had significantly lower concentrations of B than plants receiving foliar B. In all cases, application of foliar fertilizers increased the concentration of micronutrients in the tissue of *L.chinense* 'Ruby' when compared to non-treated plants.

For existing plantings of *L. chinense* 'Ruby', application of foliar Cu, Mn, Zn, and B sprays can improve the quality of plant exhibiting symptoms of decline compared to no fertilizer application. Foliar Cu sprays will provide the most noticeable improvement in plant quality. The amount of Cu to apply will vary based on the source of Cu that will be applied because the plant availability of Cu is dependent on the efficiency of the active Cu compound to release Cu^{2+} , which occurs roughly in the following order: copper sulfate pentahydrate (no lime additions) > copper hydroxide > copper tallate \approx copper ammonium complex \approx tribasic copper sulfate. Since there was no additional benefit of applying higher Cu rates to plant quality or Cu tissue concentration, application of a common Bordeaux mixture (5–2.5–100 Cu/lime mixture) should be sufficient to control symptoms of decline. To create this mixture, add 5 lbs powdered copper sulfate pentahydrate and 2.5 lbs fresh hydrated lime to 100 gallons of water. Individual plants should be sprayed thoroughly with this mixture. When *L. chinense* 'Ruby' are being treated with Cu containing fungicides (e.g., Kocide® 2000) to control pathogens, additional foliar Cu applications are not required. When using any foliar Cu treatment, avoid spraying surrounding plants as phytotoxicity may occur. These materials can also cause damage to metal surfaces

such as cars, lawn furniture, etc. In addition, applicators should wear appropriate personal protective equipment when applying foliar Cu sprays.

Since decline has only been reported on *L. chinense* 'Ruby', 'Suzanne', and 'Sizzling Pink' (6), we suggest utilizing cultivars such as 'Burgundy' or 'Plum' for new plantings of *L. chinense*. These cultivars have similar horticultural characteristics to 'Ruby' (e.g., red/purple new growth, pink flowers), but have a taller and wider growth habit (1).

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