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Copper Hydroxide Controls Root Circling In Container-Grown West Indies Mahogany and Carpentaria Palm

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Circling and deflected roots have always been a problem for the container nursery industry. Matted, kinked, and otherwise deformed roots of container-grown stock has been associated with increased mortality, poor mechanical stability, and susceptibility to drought after transplanting (Nichols and Alm, 1983). Root pruning before transplanting container-grown plants may eliminate root system deformation, but may also reduce survival and growth (Geisler and Ferree, 1984; Larson, 1980). The application of copper compounds to interior container wall surfaces prevents root growth at the container-medium interface, and may increase root growth after transplanting (Arnold and Struve, 1989; Wenny et al., 1988). Response to copper-treated containers differs among various ornamental species (Beeson and Newton, 1992). Copper treatment has helped suppress root circling in flats (Nussbaum, 1969) and tree seedling tubes (Burdett, 1978; Struve et al., 1987), but routine use of copper-treated liners for production of ornamental species has received less study.

The objective of this study was to determine if $Cu(OH)_2$ applied to all interior container surfaces could control circling root growth of two landscape tree species commonly produced in containers for planting in south Florida landscapes.

Materials and Methods

West Indies Mahogany. Mahogany seed was collected in southwestern Broward County in May of 1991. Seeds were sown on 2 July 1991 in 0.5 liter (9 cm top diameter) pots filled with 0.4 liters of a pine bark:Florida peat:sand (5:4:1 by volume) medium. After 30 days, seedlings were transplanted into 2.4 liter (15.2 cm top diameter) containers filled with 2.25 liters of the same soilless medium. A dibble application of 24 g Osmocote 17N-3P-9.9K (12 to 14 month formula; Grace/Sierra, Milpitas, CA) was applied at potting. Before planting, interior container surfaces were treated as follows: 1) untreated; 2) painted with white acrylic latex paint; 3) sprayed with a solution containing 30 ml NuFilm-17TM surfactant per liter of solution (96% di-1-p-Menthene; Miller Chemical and Fertilizer Corporation, Hanover, PA); 4) painted with white acrylic latex paint containing 100 g of $Cu(OH)_2$ per liter of paint, obtained by mixing KocideTM 101 WP

(Griffin Corporation, Valdosta, GA) with paint; 5) sprayed with a solution containing 30 ml NuFilm-17 and 100 g of $Cu(OH)_2$ per liter of solution. Seedlings were grown under full sun (1800 umol m-2 s-1 at solar noon averaged throughout the study), using daily overhead irrigation. A completely randomized experimental design was used.

Plants were harvested on 6 December 1991 by separating the plant into shoot, root, and circling root sections, and dry weights were recorded after drying the sections at 65oC for two days. Data were analyzed for significant response to Cu(OH)2 using analysis of variance, and mean comparisons were made using Duncan's New Multiple Range Test.

Carpentaria Palm. Carpentaria palm seed was collected in southwestern Broward County in March 1991 and sown in germination flats. On 9 August 1991, seedlings were transplanted into 0.5 liter (9 cm top diameter) pots filled with 0.4 liters of the same growing medium described above. A dibble application of 6 g of OsmocoteTM 17N-3P-9.9K (12-14 month formula) was applied at transplanting, and a top-dress application of the same amount was applied on 2 March 1992. Seedlings were grown under 63% black-poly shade cloth. Plants were harvested on 2 April 1992. Design, harvest and data analysis were the same as described for mahogany.

Results

Dry weights of whole plants or of whole root systems of mahogany were not influenced by any interior container surface treatments (Table 1). Without $Cu(OH)_2$, circling roots comprised 16 to 18% of mahogany root systems, increasing to 25% for the NuFilm-17 treatment. $Cu(OH)_2$ applied with paint or NuFilm-17 as a carrier almost eliminated circling root growth, reducing circling root dry weight to less than 1% of the mahogany root system.

Showing a response similar to mahogany, dry weights of whole plants or of whole root systems of carpentaria palm were not influenced by any interior container surface treatments (Table 2). Unlike mahoganies, circling roots comprised approximately 50% of the palm root system without $Cu(OH)_2$, and there was no response to the NuFilm-17 application. $Cu(OH)_2$ applied with paint or NuFilm-17 as a carrier reduced circling root growth to less than 15% of the palm root system. The coarse roots of carpentaria palm appear to be less sensitive to the 100 g $Cu(OH)_2$ treatment.

Discussion

Copper containing compounds mixed with white acrylic latex paint and applied to interior container surfaces have been shown to control root growth at the container-medium interface, and to increase root density (Arnold and Struve, 1989; Burdett, 1978; Struve et al., 1987). The 97 to 99% reduction and 85 to 90% reduction of circling root dry weight for mahogany and carpentaria palm, respectively, when either paint or NuFilm-17 was used as the carrier has shown that paint is not a required carrier when copper compounds are used to control root development. Application of $Cu(OH)_2$ in paint produced an unsightly container, while application of $Cu(OH)_2$ in NuFilm-17 was not readily visible.

If the percentage of circling roots is considered as an indicator of the degree of root system deformation, then carpentaria palm roots appear to be more sensitive to root deformation when grown in containers compared to container-grown mahogany. The growth habit of the natural root system of a species may be critical to the degree of root growth control that can be obtained using $Cu(OH)_2$.

For both mahogany and palm, application of $Cu(OH)_2$ to interior container surfaces reduced circling root growth without reducing the growth of the whole root system. Beeson and Newton (1992) reported similar

results for mahogany and windmill palm (*Trachycarpus fortunei*). Roots were forced to grow within the growing medium rather than along the container-medium interface. The increased root growth within the growing medium could provide increased root surface contact with the water and mineral elements stored in the growing medium, possibly supporting faster growth from the limited soil volume within the container. Beeson and Newton (1992) recorded faster height growth rates for mahogany grown in $Cu(OH)_2$ treated containers.

The use of $Cu(OH)_2$ treated containers when growing mahogany eliminates the need to prune roots of container-grown stock before transplanting, and may support faster growth and establishment with less mortality after transplanting (Arnold and Young, 1991). Unlike the dicotyledonous mahogany, reducing circling of the adventitious root system of the monocotyledonous carpentaria palm may be less important to establishment after transplanting (Broschat and Donselman, 1990; Meerow and Begeman, 1991). Use of Copper-treated containers may not produce the beneficial growth after transplanting palms that has been reported for other species (Arnold and Young, 1991).

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Table 1. Dry weight of whole plant, root system, circling roots, and percentage of circling roots of *Swietenia mahagoni* grown in 2.4 liter containers for 4-months after transplanting from 0.5 liter pots. Containers were treated with copper-hydroxide [$Cu(OH)_2$] in paint or NuFilm-17, with paint or Nufilm-17 only, or were untreated.

Container Treatment	Whole Plant dry Weight (grams)	Root System Dry Weight (grams)	Circling Root Dry Weight (grams)	% of Circling Roots[z]
Untreated (Control)	26.7 a[y]	8.97 a	1.46 b	16.4 b
Paint only	26.1 a	9.46 a	1.86 ab	18.7 b
NuFilm-17 only	24.2 a	9.04 a	2.26 a	25.3 a
$Cu(OH)_2$ in paint	23.5 a	7.66 a	0.04 c	0.4 c
$Cu(OH)_2$ in Nufilm-17	27.1 a	8.70 a	0.04 c	0.5 c

[z]Analysis performed on arcsine transformed data.

[y]Means within columns followed by the same letter are not different.

($P<0.05$) according to Duncan's New Multiple Range Test; n = 5.

For comparison, 28.35 grams = one ounce.

Table 2. Dry weight of whole plant, root system, circling roots, and percentage of circling roots of *Carpentaria acuminata* grown in 0.5 liter containers for 8-months after transplanting from germination flats. Containers were treated with copper-hydroxide [$Cu(OH)_2$] in paint or NuFilm-17, with paint or Nufilm-17 only, or were untreated.

Container Treatment	Whole Plant dry weight (grams)	Root System Dry Weight (grams)	Circling Root Dry Weight (grams)	% of Circling Roots[z]
Untreated (Control)	4.35 a[y]	1.50 a	0.85 a	52.4 a
Paint only	4.92 a	1.52 a	0.73 a	47.3 a
NuFilm-17 only	4.61 a	1.52 a	0.81 a	50.2 a
$Cu(OH)_2$ in paint	3.94 a	1.11 a	0.12 b	1.5 b
$Cu(OH)_2$ in Nufilm-17	4.16 a	1.21 a	0.17 b	14.6 b

[z]Analysis performed on arcsine transformed data.

[y]Means within columns followed by the same letter are not different.

($P<0.05$) according to Duncan's New Multiple Range Test; n = 10.

For comparison, 28.35 grams = one ounce.