COPPER-TREATED CONTAINERS INFLUENCE ROOT DEVELOPMENT OF LONGLEAF PINE SEEDLINGS

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ABSTRACT—Development of longleaf pine (*Pinus palustris* Mill.) seedlings grown in Copperblock™ containers and BC/CFC First Choice™ Styrofoam blocks, with applications of Spin Out® root growth regulator, were compared to control seedlings. The copper treatments significantly changed seedling morphology; at outplanting, dry weights of both roots and tops were greater than for control stock. Evaluations made 30 days after planting seedlings in a sand stress-bed environment showed that root egress from the treated containers was greater than from the control.

INTRODUCTION

From the development and earliest use of container production technology, copper treatments have been used to modify root growth of tree seedlings. Early use was with seedlings grown in Paperpots™ to prevent root egress from the bottom of containers (Barnett and McGilvray 1974, Saul 1968), but soon researchers began evaluating the coating of interior walls of container cavities (McDonald and others 1984a, 1984b; Ruehle 1985). Without root pruning by a copper treatment, the root plug produces many roots on the outside of the plug, typically forming a “cage” with few roots in the middle and clustered root tips at the bottom of the container (Struve 1993, Watt and Smith 1999). Such root systems usually will produce new roots from the cluster of root tips at the bottom of the plug. These root systems may produce seedlings that are unstable after planting (Ruehle 1985, Struve and others 1994).

The use of copper-treated containers may improve root configuration. A copper coating on container cavity walls inhibits cell division at the root apex and inhibits root elongation at the root/container-wall interface (Watt and Smith 1999). An abundance of higher-order lateral roots is created, and their growth is stopped at the container wall. This results in a root system with many short, branched roots within the plug. After outplanting, root tips resume growth and produce a more branched root system. More roots are in the top 1/3 of the plug where they better exploit water and nutrient resources and result in better seedling stability (Ruehle 1985, Smith and McCubbin 1992).

Such means of root pruning have other benefits for container tree seedlings. Romero and others (1986) analyzed root development of copper-carbonate treated Caribbean pine (*Pinus caribaea* Morelet) and found that treated seedlings had more lateral roots, as well as significantly larger stem diameters, than control seedlings. They also noted a change in root morphology. Treated seedlings had finer, more fibrous root systems and were easier to extract from containers. However, the major benefits of chemical root pruning seem to occur after outplanting. Our study evaluated the effects on longleaf pine (*P. palustris* Mill.) seedling development when seedlings are produced in copper-treated trays.

METHODS

The seedlings originated from bulked lots of longleaf pine orchard seeds adapted to the Western Gulf Coastal Plain. They were grown at the Southern Research Station’s research facility in Pineville, LA, following guidelines for producing longleaf pine container stock (Barnett and McGilvray 1997).

We grew all seedlings in Styroblock 112 containers and evaluated a control and three copper treatments. In two treatments we used Beaver Plastics’ Copperblock™ containers (Beaver Plastics, 12150 - 160 Street, Edmonton, Alberta, Canada T5V 1H5) at 0.5x and 1x rates of copper application. The Copperblock™ containers are designed to leave a portion of the cell untreated. Wide untreated ribs extend from top to bottom of the cells. The third copper treatment was BC/CFC First Choice™ containers coated with Spin Out® (Griffin LLC, P.O. Box 847, Valdosta, GA 31603-1847). The Surrey Nursery in British Columbia applied Spin Out® to First Choice™ containers using a sprayer specifically designed to treat the entire inside cell walls. We grew seedlings in a 1:1 peat-vermiculite medium after sowing in late April 1999.

The study was a randomized experiment with five replications of two styroblock containers (96 cavities each) per treatment. Three-seedling samples from each replication were taken in mid-July and again in November to evaluate the treatment effects. We determined dry weights of tops and roots and measured root-area indices (RAI) using a Delta-T device area meter (Decagon Devices Ltd.) in July and 30 days after outplanting in a sand stress-bed. The RAI in July measured root systems washed from seedling plugs. We removed roots extending beyond the plug surface measured them separately at 30 days after outplanting. We conducted statistical analyses of the randomized treatments and determined differences at the 0.05 level of probability.

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RESULTS

The effects of the copper treatments on root development of longleaf pine seedlings differed by the time of year of sampling. When sampled in July (mid-season), top weights from the copper treatments were statistically greater than for the controls (table 1). Root-area indices of the controls were larger than for the copper treatments. Although control seedling weights were numerically larger than the treatments, the differences among root weights were not statistically significant. In November, seedlings grown in copper cells also had greater top weights than the controls. The root weights in copper cells were larger than in controls, but they were not statistically significant. Thirty days after seedlings were outplanted into sand stress-beds, root growth was greater for the copper treatments than for the controls.

Although research personnel made no mechanical measurements, those who removed seedlings from the containers reported that seedlings grown in copper-treated plugs were much easier to extract. Also, seedlings grown in Spin Out® cells were easier to extract than those grown in Copperblock™, either because the latter have untreated areas within cavities or because a less effective binding agent is used during copper application.

These results indicate that changing root morphology by coating cavity walls not only shifts root growth patterns by limiting root growth at the cavity wall-growing medium interface, but also affects seedling development. Early in the growing period, copper tends to reduce root weight development. Later, overall root weights in copper treatments are greater than in the controls. We believe that copper treatment results in more growth of the tap root as the length of lateral root growth is inhibited, but that the fibrous roots produced are better distributed within the container cavity. We did not evaluate the effect of copper treatment on nutrient status of the seedlings. Abundant nutrients were provided during the cultural period, so only if copper affected the balance of nutrients would seedling growth be affected.

CONCLUSIONS

The faster growth of roots from the seedling plug surface when outplanted indicates that field performance of seedlings grown in copper-coated containers may be improved. However, such field evaluations were not a part of this study. Other studies are underway to evaluate the field performance of longleaf pine seedlings grown in copper-treated containers.

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Table 1—Effects of copper-treated styroblocks on longleaf pine root development as measured in July, November, and 30-days after outplanting into stress beds[a]

	Mid-season (10 wks.)			Final (24 wks.)		Planting +30 days
Treatments	Top wt.	Root wt.	RAI	Top wt.	Root wt.	RAI
	mg	*mg*	*cm²*	*mg*	*mg*	cm²
Control	1.14a	294a	30b	2.89a	1.23a	93
CB 0.5x™	1.33b	239a	17a	3.60c	1.35a	122
CB 1x™	1.38c	224a	18a	3.46b	1.44a	111
Spin Out®	1.45d	273a	19a	3.67c	1.51a	191

[a] The values represent averages of 15 seedlings (3 seedlings each from 5 replications). The CB treatments refer to Copperblock™. Values within columns followed by the same letter are not significantly different at the 0.05 level. Insufficient replication of the Planting +30 days RAIs prevented statistical analysis of these data.

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