Southern Forest
Nursery Management Cooperative

RESEARCH REPORT 19-02

COPPER TRIALS ON LOBLOLLY PINE SEEDBEDS

by
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INTRODUCTION

In bareroot forest-tree seedling nurseries, soil and foliar samples are used to determine deficiencies of micro- and macronutrients necessary for optimum seedling growth and for fertilization recommendations. The micronutrient copper (Cu) increases the activity of enzymes and is necessary for photosynthesis and for lignin formation in conifers. Its use in agriculture began as a herbicide for weed control, then was found to be an effective fungicide when first used on grape crops in the 1880's in Bordeaux, France.

Visible symptoms of copper deficiencies in conifer seedlings in southern U.S. bareroot nurseries are difficult to recognize because these have not been as frequently identified as have symptoms of other nutrient deficiencies such as magnesium or potassium. In conifer seedlings, low copper levels and availability of its uptake may appear similar to low potassium levels as chlorosis. Copper-deficient seedlings may have twisted or curled young needles, may exhibit a reduced ability to tolerate moisture stress, and may exhibit incremental banded color changes starting at the tip of the needle downward. Symptomology of insufficient copper in pine plantations in the southern U.S. has been reported as shoots growing in horizontal rather than vertical planes, limp or stunted needles and twisted branches or stems. Current operational applications of copper fertilizer in forest-tree nurseries include incorporating recommended amounts of copper sulfate into the nursery soil prior to sowing. An alternative to this method may be the use of liquid copper applied during the growing season in an over-the-top application. The objective of this trial was to determine the level of tolerance of loblolly pine to liquid copper applications made during the growing season.

METHODOLOGY

This study was installed in late June and early July of 2018 on loblolly pine seedbeds at the K & L Forest Nursery in Buena Vista, Georgia and the Rayonier Nursery in Elberta, Alabama. Levels of copper in soil and foliage were not measured prior to or after copper applications due to the single study objective of determining seedling tolerance and the desire to determine toxicity symptomology. A Helena Agri-Enterprises (formerly Helena Chemical) product, Ele-Max® Copper FL 4-0-0, was used. This product contains 33% copper and 4% nitrogen. Its recommended labeled rate for foliar application on conifers is 8 oz./acre to be applied when new season leaf production occurs with a second application made in early autumn. For this trial, rates of 4 times, 8 times and 32 times the recommended single application rate were used in an attempt to induce seedling injury. Quantities of

32, 128 and 256 ounces per acre were applied over-the-top of loblolly pine seedlings at approximately 8 weeks post-sowing. The Ele-Max® Copper FL label instructs applicators to use a spray mixture with a pH greater than 6.0, so pH levels were measured at each nursery and spray mixtures buffered if necessary.

Each treatment was one seedling bed wide by 8 feet in length replicated five times. Ele-Max® Copper FL was applied by SFNMC staff with a CO_2 hand sprayer calibrated to broadcast spray 25 gallons per acre. In October and November 2018, sample seedlings were collected at each nursery by removing all seedlings within a counting frame in each treatment plot while bundling seedlings from inside rows separately from those of outside rows. At the SFNMC laboratory, counts of all seedlings were made for measures of density. Samples of 25 seedlings from interior rows of each treatment plot were removed and evaluated at the SFNMC laboratory for tolerance to the liquid copper. Measurements of shoot height, root collar diameter, root dry weight and shoot dry weight were made and compared to those from seedlings in non-treated control plots. Statistical analyses using Duncan's Multiple Range test, Dunnett's T-test and Wilcoxon Method for Nonparametric Comparisons, all at alpha = 0.05, were examined on data collected.

RESULTS AND DISCUSSION

During the growing season, no visible signs of damage to seedlings (chlorosis, stunted or dead needles, or stem damage) were observed. After analyzing 1,000 seedlings (500 per nursery), no significant differences were quantified in seedling density, shoot dry weight, root dry weight, root collar diameter or shoot heights when seedlings treated with Ele-Max® Copper FL were compared to those collected from non-treated control plots. These results were consistent across all plots, regardless of rate applied (Table 1). The density of seedlings in Nursery B shows a trend of fewer seedlings per square foot in treated plots when compared to non-treated control plots but these results were not statistically significant.

MANAGEMENT IMPLICATIONS

- When recommended, the use of copper sulfate incorporated into the soil prior to sowing is a fertilization practice used by forest-tree seedling nurseries. The use of a liquid product such as Ele-Max® Copper FL provides an alternate method of delivery of copper to loblolly pine seedlings, particularly if copper deficiency has been quantified or if symptoms appear during the growing season.

- As with any new product used in a forest-tree nursery, testing in a small area should be done prior to adopting this product for operational use due to variations in soil type and soil and water pH.

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Table 1. Loblolly pine seedling characteristics (measured in October and November 2018) treated with three rates of copper at 8 weeks post-sowing (in June and July 2018) in two nurseries.

Nursery	Rate	Density (ft^2)	Shoot Height (cm)	RCD (mm)	Shoot Weight (g)	Root Weight (g)	Root Weight Ratio (%)	Height: Diameter Ratio[1]
A	0 oz./ac	28.6	29.7	4.18	2.61	0.47	15.2	72.3
	1 qt./ac	27.6	29.6	4.15	2.60	0.46	15.1	73.4
	4 qt./ac	27.9	29.6	4.21	2.66	0.46	14.7	71.6
	8 qt./ac	29.3	30.6	4.20	2.57	0.46	15.2	74.5
	LSD=0.1	3.4	1.0	0.26	0.33	0.05	1.0	
B	0 oz./ac	22.5	23.8	3.84	2.40	0.36	13.2	62.9
	1 qt./ac	20.0	24.1	3.87	2.31	0.38	14.2	62.6
	4 qt./ac	20.7	22.5	3.88	2.37	0.37	13.6	57.7
	8 qt./ac	20.8	23.8	4.05	2.43	0.38	13.5	58.7
	LSD=0.1	3.3	1.5	0.32	0.39	0.08	1.1	

Different letters (a, b) within a seedling characteristic column indicate significant treatment differences in rates according to Duncan's Multiple Range test at alpha = 0.05.

Single underlined means within a seedling characteristic indicate significant treatment difference from that of the non-treated control at that rate according to Dunnett's T-test at alpha = 0.05.

[1] Height:diameter ratio is used as a measure of seedling 'sturdiness'. A higher ratio is interpreted as a more 'spindly' seedling; a lower ratio is interpreted as a more 'stout' seedling.