Southern Forest Nursery Management Cooperative

RESEARCH REPORT 19-03

MICRONUTRIENT USE ON LOBLOLLY PINE SEEDBEDS

by
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INTRODUCTION

As plant and tissue analyses have become more precise for agricultural operations, prescriptions for micronutrient applications are becoming more common. The micronutrient fertilizer market has expanded as higher crop yields require more of these nutrients. These ‘trace’ nutrients (iron, calcium, magnesium, manganese, zinc, copper, boron, aluminum, sodium and molybdenum, among others) are needed in small amounts by plants but can also be harmful if present in excessive amounts.

Bareroot conifer tree seedling nurseries in the southeastern U.S. are generally sited on coarse textured soils to provide benefits in mechanical operations and drainage. However, these soils also have less nutrient retention than finer soils. Research on minimum micronutrient levels and ranges of micronutrients that are optimal for conifer seedling growth was conducted primarily in the 1980s. Information on the balance of nutrients in proportion to one another in loblolly pine seedlings is limited, resulting in a lack of knowledge on the effects of potentially overfertilizing and causing toxicity by disrupting this balance.

Conifer forest-tree seedling nurseries are rarely included in the development of products that could be useful in seedling development and nursery management. Recently, producers and suppliers of micronutrient fertilizers have contacted conifer nurseries about the potential advantages of using these products. The objective of this study was to determine the effects of three commercially available fertilizer products on seedling tolerance and toxicity in bareroot loblolly and slash pine. Assessing increased seedling productivity and growth as a result of fertilizer applications was not included as an objective in this study.

METHODOLOGY

Fertilizer products, ingredients and rates used are listed in Table 1. The bareroot nursery sites included in this study were the IFCO Nursery at Jesup, Georgia, the K & L Forest Nursery in Buena Vista, Georgia, and the Rayonier Nursery in Elberta, Alabama. Loblolly pine seedbeds were used at each site, and slash pine seedbeds were included at the Rayonier Nursery. The first application of the three products was made at approximately 8 weeks post-sowing (late June or early July) at each site. Subsequent applications were made according to product label and supplier prescriptions two weeks later (mid-July), then at three-week intervals until late August. A total of 4 applications were made on each test site. Because this was a replicated trial, each study installation area was treated with the same three products at identical rates, times and application method, without regard for existing micronutrient deficiencies or excesses at each site. Each product was applied according to its individual label, with requirements for buffering of the tank mixture or the use of surfactants followed when directed.

Each study was installed in a randomized block design with each treatment being one seedling bed wide by 8 feet in length, replicated five times. The SFNMC staff applied products at recommended rates from product representatives and seedling growers using a CO_2 hand sprayer calibrated to broadcast spray 25 gallons per acre.

Seedlings from test plots were collected in early October and November 2018. In the field, all seedlings from within one counting frame per test plot were removed and returned to the SFNMC laboratory for processing. Counts of all seedlings were made for density measurements, while random samples of 25 interior row seedlings were used for measurements of seedling height, root collar diameter, shoot dry weight and root dry weight. Measurements of treated seedlings were compared to those of nontreated control seedlings to determine tolerance to applications of the herbicides. Data was analyzed and examined using Dunnett's T-test and Wilcoxon Method for Nonparametric Comparisons, all at alpha = 0.05.

In the SFNMC laboratory, foliar samples were collected from seedlings in each treatment and sent to Waypoint Analytical for analysis of micronutrient concentration. No statistical analysis was performed as samples were not processed by replication but rather by treatments as a whole.

RESULTS AND DISCUSSION

Analyses of 2,000 seedlings measured produced no biologically significant differences in seedling quality measurements when nontreated seedlings were compared with seedlings treated with each product (Tables 2 and 3). Loblolly pine seedlings in one nursery did show statistically significant lower shoot heights in those seedlings treated with FoliarBlend® and Megafol® than in nontreated seedlings, but these height differences amount to less than 1.3 centimeters. Root collar diameters in the same nursery in the FoliarBlend® plots were statistically smaller, but less than 0.2 millimeters smaller than diameters of nontreated seedlings. In slash pine, seedling counts in the Megafol® plots were statistically greater than those in control plots, but this difference cannot be attributed to use of a fertilizer product as seedlings were initially sprayed at 8 weeks post-sowing, well after the germination period.

Foliar nutrient analysis results, sorted by nutrient product tested, are shown in Tables 4, 5 and 6. It should be noted that no foliar samples were found to be deficient in the nutrients added by the three fertilizer products, either in nontreated or treated samples.

MANAGEMENT IMPLICATIONS

- Nursery-specific product recommendations tailored to increase seedling growth at each site (using soil and foliar micronutrient levels measured prior to product selection and application) were not included in this study, so more precise analysis of these three or other available products should be done within individual nurseries in order to target specific micronutrient deficiencies. Testing of higher rates, number of applications and timing of applications should be included.

- The decision to apply macro- and micronutrients at any bareroot forest-tree seedling nursery should be site and crop-specific using soil and foliar nutrient analyses and knowledge of minimum micronutrient level requirements of pine seedlings.

- An option available to customize fertilizers specific to certain crops or areas of a field, for example, is to separate micro- and micronutrient fertilizer applications to better target micronutrient deficiencies present.

ACKNOWLEDGEMENTS
The authors wish to thank Ricky Sloan of Helena Agri-Enterprises and Davey Rehburg of Advanced Ag Solutions for provision of the product samples used in this trial, and the staff and management of the IFCO Jesup, GA Nursery, the Rayonier Nursery and the K & L Forest Nursery for provision of bed space and seedlings.

REFERENCES
Boyer, J. and D.B. South. 1985. Nutrient content of nursery-grown loblolly pine seedlings. Alabama Agricultural Experiment Station Cir. 282. Auburn University, Alabama.

Currey, C.J. 2019. “Micronutrient Considerations.” Greenhouse Management. March 2019. GreenhouseMag Web. 27 March 2019.

Maxwell, J.W. 1988. Macro and micronutrient programmes in B. C. bareroot nurseries. Proc. Combined Meeting of the Western Forest Nursery Associations. August 8-11, 1988. Vernon, British Columbia.

Powers, R.F. 1974 Evaluating fertilizer programs using soil analysis, foliar analysis, and bioassay methods. In: Proceedings, Service Wide Silviculture Work Conference. Washington, D.C.: U.S. Department of Agriculture, Forest Service, Division of Timber Management: 124-162.

South, D. B. 2018. Fertilizer trials for bareroot nurseries in North America. Reforesta 5: 54-76.

South, D.B., R.L. Nadel, S.A. Enebak and G. Bickerstaff. 2018. The nutrition of loblolly pine seedling exhibits both positive (soil) and negative (foliage) correlations with seedling mass. Tree Planters’ Notes. 61 (2):5-17.

Starkey, T. and S. Enebak. 2012. Foliar nutrient survey of loblolly and longleaf pine seedlings. Research Report 12-02. Auburn, AL: Auburn University, Southern Forest Nursery Management Cooperative. 11p.

Table 1. Products, ingredients and rates used in micronutrient trial in June, July and August 2018.

Trade Name	Manufacturer	Rate	Ingredients (%)									
			B	Co	Cu	Fe	Mg	Mn	Mo	N	K_2O	Zn
Axilo® Mix 5	Valagro®	1 lb./ac	0.5		1.5	4.0	3.0	4.0	0.1			1.5
Megafol®	Valagro®	1 pt./ac								3.0	8.0	
FoliarBlend®	AgriGro	1 pt./ac	0.03	0.002				0.1	0.002	1.0		0.05

Table 2. Loblolly pine seedling characteristics (measured in October and November 2018) treated with three nutrient products at 8, 10, 12 and 15 weeks post-sowing (in June, July and August 2018) in three nurseries.

Nursery	Product	Seedling Density (ft^2)	Shoot Height (cm)	RCD (mm)	Shoot Weight (g)	Root Weight (g)	Root Weight Ratio[1] (%)	Height: Diameter Ratio[2]
A	Control	19.6	32.3	4.84	4.41	0.65	12.8	67.2
	Axilo®	19.7	31.8	4.77	4.33	0.67	13.4	67.8
	FoliarBlend®	19.4	<u><u>31.2</u></u>	<u>4.64</u>	4.18	0.64	13.3	67.8
	Megafol®	20.9	<u><u>31.0</u></u>	4.70	4.15	0.68	13.9	66.8
B	Control	29.7	28.4	3.89	2.25	0.38	14.3	74.4
	Axilo®	31.0	28.2	3.80	2.18	0.34	13.5	75.4
	FoliarBlend®	29.1	27.4	3.82	2.18	0.37	14.4	73.3
	Megafol®	29.4	29.1	3.90	2.33	0.39	14.1	76.3
C	Control	21.0	25.0	4.09	2.59	0.41	13.6	62.6
	Axilo®	20.5	26.2	4.27	2.72	0.41	13.0	62.8
	FoliarBlend®	23.2	24.5	4.06	2.44	0.38	13.5	61.6
	Megafol®	20.8	25.3	4.05	2.48	0.38	13.5	64.0

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

Double underlined means within a seedling characteristic indicate a significant treatment difference from that of the nontreated control at that rate according to nonparametric Wilcoxon test at alpha = 0.05.

[1]Root weight ratio is used as a measure of seedling quality. Target RWR as recommended by the SFNMC is >27% and is calculated by dividing the dry weight of the root by the total dry seedling weight and expressed as a percentage.

[2]Height:diameter ratio is used as a measure of seedling 'sturdiness' in seedling quality evaluations done by the SFNMC. A higher ratio is interpreted as a more 'spindly' seedling; a lower ratio is interpreted as a more 'stout' seedling. It is calculated by dividing shoot height (in mm) by RCD (in mm).

Table 3. Slash pine seedling characteristics (measured in October) treated with three nutrient products at 8, 10, 12 and 15 weeks post-sowing (in July and August) in one nursery.

Product	Density (ft^2)	Shoot Height (cm)	RCD (mm)	Shoot Weight (g)	Root Weight (g)	Root Weight Ratio[1] (%)	Height: Diameter Ratio[2]
Control	23.8	25.5	3.89	2.66	0.35	11.9	66.2
Axilo®	25.2	25.0	3.87	2.49	0.39	13.7	65.3
FoliarBlend®	25.0	25.0	3.84	2.42	0.36	12.9	65.8
Megafol®	<u>26.6</u>	25.5	3.97	2.58	0.36	12.3	64.8

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

[1]Root weight ratio is used as a measure of seedling quality. Target RWR as recommended by the SFNMC is >27% and is calculated by dividing the dry weight of the root by the total dry seedling weight and expressed as a percentage.

[2]Height:diameter ratio is used as a measure of seedling 'sturdiness' in seedling quality evaluations done by the SFNMC. A higher ratio is interpreted as a more 'spindly' seedling; a lower ratio is interpreted as a more 'stout' seedling. It is calculated by dividing shoot height (in mm) by RCD (in mm).

Table 4. Loblolly and slash pine seedling foliar nutrient levels (measured in January 2019) treated with Axilo® at 8, 10, 12 and 15 weeks post-sowing (in June, July and August 2018) in three nurseries. Nutrients listed in bold are those included in the Axilo® product.

Nursery	Species	Product	N (%)	S (%)	P (%)	K (%)	**Mg (%)**	Ca (%)	Na (%)	**B (ppm)**	**Zn (ppm)**	**Mn (ppm)**	**Fe (ppm)**	**Cu (ppm)**	Al (ppm)
		Deficient Levels[a]	*<1.1*	*<0.1*	*<0.09*	*<0.4*	***<0.05***	*<0.12*		***<3***	***<5***	***135-1677***[b]	***<30***	***<3***	*185-2097*[b]
A	Loblolly	Control	1.58	0.17	0.18	0.82	**0.13**	0.26	0.04	**23**	**56**	**458**	**275**	**12**	433
	Loblolly	Axilo®	1.54	0.17	0.16	0.93	**0.12**	0.34	0.04	**22**	**56**	**436**	**454**	**11**	485
B	Loblolly	Control	1.64	0.12	0.15	0.66	**0.07**	0.27	0.01	**47**	**60**	**1197**	**87**	**8**	480
	Loblolly	Axilo®	1.76	0.12	0.14	0.62	**0.08**	0.28	0.01	**48**	**54**	**1120**	**119**	**6**	488
C	Loblolly	Control	1.49	0.09	0.14	0.49	**0.08**	0.30	0.02	**42**	**57**	**802**	**105**	**7**	437
	Loblolly	Axilo®	1.39	0.09	0.12	0.48	**0.07**	0.27	0.02	**42**	**44**	**653**	**103**	**6**	364
C	Slash	Control	1.29	0.10	0.20	0.52	**0.05**	0.30	0.04	**14**	**41**	**855**	**68**	**5**	268
	Slash	Axilo®	1.55	0.10	0.18	0.59	**0.06**	0.29	0.03	**14**	**39**	**749**	**95**	**5**	274

[a]Deficiency levels reported by Powers (1974).
[b]Range of surveyed values (manganese and aluminum) reported by Starkey and Enebak (2012).

Table 5. Loblolly and slash pine seedling foliar nutrient levels (measured in January 2019) treated with FoliarBlend® at 8, 10, 12 and 15 weeks post-sowing (in June, July and August 2018) in three nurseries. Nutrients listed in bold are those included in the FoliarBlend® product.

Nursery	Species	Product	**N (%)**	S (%)	P (%)	K (%)	Mg (%)	Ca (%)	Na (%)	**B (ppm)**	**Zn (ppm)**	**Mn (ppm)**	Fe (ppm)	Cu (ppm)	Al (ppm)
		Deficient Levels[a]	***<1.1***	*<0.1*	*<0.09*	*<0.4*	*<0.05*	*<0.12*		***<3***	***<5***	***135-1677***[b]	*<30*	*<3*	185-2097[b]
A	Loblolly	Control	**1.58**	0.17	0.18	0.82	0.13	0.26	0.04	**23**	**56**	**458**	275	12	433
	Loblolly	FoliarBlend®	**1.51**	0.18	0.16	0.84	0.12	0.33	0.04	**22**	**58**	**444**	379	15	511
B	Loblolly	Control	**1.64**	0.12	0.15	0.66	0.07	0.27	0.01	**47**	**60**	**1197**	87	8	480
	Loblolly	FoliarBlend®	**1.72**	0.12	0.15	0.66	0.07	0.29	0.02	**49**	**64**	**1162**	111	9	508
C	Loblolly	Control	**1.49**	0.09	0.14	0.49	0.08	0.30	0.02	**42**	**57**	**802**	105	7	437
	Loblolly	FoliarBlend®	**1.52**	0.10	0.14	0.55	0.08	0.29	0.02	**35**	**48**	**661**	146	6	340
C	Slash	Control	**1.29**	0.10	0.20	0.52	0.05	0.30	0.04	**14**	**41**	**855**	68	5	268
	Slash	FoliarBlend®	**1.49**	0.11	0.16	0.59	0.06	0.28	0.03	**15**	**43**	**716**	106	6	290

[a]Deficiency levels reported by Powers (1974).
[b]Range of surveyed values (manganese and aluminum) reported by Starkey and Enebak (2012).

Table 6. Loblolly and slash pine seedling foliar nutrient levels (measured in January 2019) treated with Megafol® at 8, 10, 12 and 15 weeks post-sowing (in June, July and August 2018) in three nurseries. Nutrients listed in bold are those included in the Megafol® product.

Nursery	Species	Product	**N (%)**	S (%)	P (%)	**K (%)**	Mg (%)	Ca (%)	Na (%)	B (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)	Al (ppm)
		Deficient Levels[a]	***<1.1***	*<0.1*	*<0.09*	***<0.4***	*<0.05*	*<0.12*		*<3*	*<5*	*135-1677*[b]	*<30*	*<3*	185-2097[b]
A	Loblolly	Control	**1.58**	0.17	0.18	**0.82**	0.13	0.26	0.04	23	56	458	275	12	433
	Loblolly	Megafol	**1.60**	0.17	0.17	**0.78**	0.13	0.29	0.04	24	57	524	46	7	280
B	Loblolly	Control	**1.64**	0.12	0.15	**0.66**	0.07	0.27	0.01	47	60	1197	87	8	480
	Loblolly	Megafol	**1.71**	0.13	0.14	**0.59**	0.09	0.27	0.01	47	59	1189	133	10	503
C	Loblolly	Control	**1.49**	0.09	0.14	**0.49**	0.08	0.30	0.02	42	57	802	105	7	437
	Loblolly	Megafol	**1.34**	0.09	0.12	**0.47**	0.07	0.27	0.02	32	46	704	82	6	319
C	Slash	Control	**1.29**	0.10	0.20	**0.52**	0.05	0.30	0.04	14	41	855	68	5	268
	Slash	Megafol	**1.44**	0.10	0.16	**0.44**	0.05	0.24	0.03	14	34	727	70	4	279

[a]Deficiency levels reported by Powers (1974).
[b]Range of surveyed values (manganese and aluminum) reported by Starkey and Enebak (2012).