ENDOMYCORRHIZAL INOCULUM IMPROVES GROWTH OF NURSERY-GROWN SWEETGUM SEEDLINGS

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Abstract.--Sweetgum seedlings grown on fumigated seedbeds under operational conditions in two southern forest nurseries showed significant growth increases when inoculated with an endomycorrhizal fungus. Height growth, root collar diameter, and endomycorrhizal infection of inoculated seedlings were respectively 37, 25 and 75 percent greater than noninoculated seedlings.

Additional keywords: *Liquidambar styraciflua*, *Glomus mosseae*, endomycorrhizae, height growth, root collar diameter, soil fumigation.

INTRODUCTION

Economic demands for quality southern hardwoods have increased efforts to regenerate certain species artificially. Sweetgum (*Liquidambar styraciflua* L.) has proven to be one of the most potentially desirable species due to its adaptability, growth rate, and wood quality.

A major deterrent to successful establishment of sweetgum plantations has been an inability of nurseries to consistently produce quality seedlings. One possible explanation for "poor" seedling quality may be a lack of beneficial endomycorrhizal fungi. The common practice of nursery seedbed fumigation appears to reduce fungal populations and adversely alter the development of endomycorrhizae (Filer and Toole 1968).

Bryan and Ruehle (1976) showed in a greenhouse study that sweetgum seedlings grown in fumigated soil and inoculated with *Glomus mosseae* (Nicol. and Gerd.) (Gerd. and Trappe) grew significantly faster than those in nonfumigated soil. Because of the apparent benefits of endomycorrhizae, a study was established to determine what effect artificial inoculation of *G. mosseae* would have on sweetgum seedlings grown under operational conditions in two southern forest tree nurseries.

METHODS

Prior to plot establishment, seedbed areas were fumigated in March, with approximately 450 kg/ha of methyl bromide (Dowfume MC-2[R])[2/]. Seedbeds were developed and the study was installed in a randomized complete block design

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[2/] Mention of trade name is solely to identify material used and does not constitute endorsement by International Paper Company.

with six replications in each nursery. Four treatments consisted of a control and three levels of G. mosseae inoculum composed of spores, chopped sorghum roots and soil from greenhouse pot cultures. Inoculum levels were calculated on a dry weight basis and were approximately 2.1, 6.2, 12.4 kg/m^2 respectively. Inoculum was spread evenly over the 5.6 m^2 (15 linear bed feet) plots and chopped into a depth of 10.2 cm (4 inches). Control plots received no inoculum.

Sweetgum seed from a common source were planted by the respective nursery personnel for 8 to 10 seedlings per square foot and treated just as the adjacent operational crop for the remainder of the growing season. Soil samples were taken throughout the growing season to determine pH, organic matter, Ca, P, K, Mg, and Mn.

Six weeks after planting and every three weeks thereafter, until termination of the study, seedlings were sampled to determine height growth, root collar diameter and/or endomycorrhizal development. Root segments were removed from the root systems of sample seedlings. These segments were cleared and stained according to the procedure of Phillips and Hayman (1970) and examined microscopically to determine endomycorrhizal infection. The percentage of infection of seedling roots was determined by comparing numbers of infected segments with numbers of noninfected segments.

RESULTS

Sweetgum seedlings inoculated with G. mosseae showed significant advantages over noninoculated seedlings when grown in fumigated nursery soil in the spring (Table 1). Inoculated seedlings were approximately 37, 25 and 75 percent greater than noninoculated seedlings in height, root collar diameter, and endomycorrhizal infection respectively.

Table 1.--Analysis of combined data from Columbia and Winona Nurseries.

Variable	Week	Nursery		Treatment[a]			
		Columbia	Winona	I	II	III	Control
$\bar{x}$ height (cm)	15	13.66	23.52	19.51	19.85	19.96[b]	15.04
	33	22.50	55.32	43.28	41.48	40.53	30.36
$\bar{x}$ root collar (mm)	15	2.48	2.80	2.75	2.74	2.85	2.20
	33	5.13	6.20	5.98	5.89	6.04	4.75
% myc. inf.	15	47.80	63.77	71.53	72.60	71.18	7.59
	33	50.35	72.75	67.25	73.93	65.76	39.27

a/ Treatment inoculum levels I, II, and II were 2.1, 6.2, and 12.4 kg/m^2 respectively. Controls received no inoculum.

b/ Numbers connected by a straight line are not significantly different at 95% confidence level using Tukey's ω-procedure.

Fumigation of the nursery soil apparently eliminated the majority of endomycorrhizal fungi. This was evidenced by the fact that controls remained basically nonmycorrhizal until about the twelfth week following planting. Once noninoculated seedlings became infected with natural inoculum their growth rate was approximately equal to that of inoculated seedlings. Noninoculated seedlings were never able to make up the early growth lost due to a lack of endomycorrhizae early in the growing season.

Treatment effects were practically the same at both nurseries, although seedling quality varied by nursery. No significant differences were observed between inoculated treatments, which indicates that relatively low levels of endomycorrhizal inoculum were sufficient to stimulate early growth of seedlings.

DISCUSSION

Growth stimulation of sweetgum seedlings indicates that this species ~~is~~ highly dependent upon endomycorrhizae. These endomycorrhizal fungi are greatly reduced by soil fumigation in the spring. Fall fumigation may be better than spring fumigation because of the additional time allowed for soil conditions to stabilize.

Inoculation of sweetgum seedbeds proved beneficial when following spring fumigation. The feasibility of this practice at present is questionable for large seedling crops. Perhaps a better solution would be to have enough nursery space to fumigate and cover crop a year prior to planting. Depending upon the cover crop selected, endomycorrhizal fungi could possible be manipulated to produce optimum population levels.

Seedling quality varied by nursery while the treatment effects remained the same. Soil analyses revealed a possible phosphorous (P) deficiency in the hardwood seedbeds at the Columbia nursery. The P level would probably have been adequate for pine, but hardwoods seem to require about twice as much P for maximum growth.

The inconsistency of production of quality hardwoods in pine oriented nurseries may be a combination of minimal nutrients and fumigated soil. Minimal nutrients may become more of a growth factor when soils are fumigated and endomycorrhizal fungi are eliminated.

Seedling quality in any nursery is the end result of a number of contributing factors. Endomycorrhizae appears to be one of the main factors affecting the growth and development of sweetgum seedlings. Therefore, anything a nurseryman can do to improve early endomycorrhizal development in his sweetgum seedlings the better chance he has of a successful crop.

LITERATURE CITED

Bryan, W. C. and Ruehle, J. E. 1976. Growth stimulation of sweetgum seedlings induced by the endomycorrhizal fungus Glomus mosseae. Tree Planter's Notes 27:9, 24.

Filer, T. H., Jr., and Toole, E. R. 1968. Effect of methyl bromide on mycorrhizae and growth of sweetgum seedlings. Plant Dis. Reptr. 52:483-485.

Phillips, J. M. and Haymen, D. S. 1970. Improved procedures for clearing roots and staining parasitic vesicular-arbuscular mycorrhizae fungi for rapid assessment of infection. Trans. Br. Mycol. Soc. 55:158-161.