

THE OPERATIONAL APPLICATION OF PISOLITHUS
TINCTORIUS ECTOMYCORRHIZAE IN FOREST TREE
NURSERIES FOR CUSTOM SEEDLING PRODUCTION

Charles E. Cordell and Donald H. Marx^{1/}

Abstract.--Forest tree nursery and field outplanting results continue to be encouraging for the effective practical application of P.t. ectomycorrhizae for custom seedling production. The use of this unique biological tool in container and bareroot nurseries, field forestation, and reclamation sites is progressing rapidly. Several alternative types of P.t. inoculum are available along with effective practical techniques for nursery seedbed inoculations. Major emphasis is being placed on the production of P.t. "tailored" seedlings for specific sites, selected tree species, and related, high-value forest products.

Additional key words: Pisolithus tinctorius (P.t.) ectomycorrhizae, P.t. mycelium inoculum, P.t. spore-encapsulated seed, ectomycorrhizal inoculum applicator - nursery seeder, bareroot nurseries, container nurseries, forestation sites, reclamation sites.

For several years, forestry agencies and firms have been interested in custom-grown ectomycorrhizal seedlings. Such seedlings may grow better than other seedlings when used to reclaim adverse sites. Better stands of specific tree species may also result, as well as high-value forest products. With these objectives, the national P.t. ectomycorrhizae program has developed techniques and procedures for use in container and bareroot tree nurseries (Cordell and Webb, 1980; Marx and others, 1982; Marx and others, 1983). This effort has been greatly enhanced by the commercial production of P.t. vegetative inoculum, production of P.t. spore-encapsulated seed and, more recently, by the development and commercial production of an ectomycorrhizal inoculum applicator - bareroot nursery seeder.

OPERATIONAL P.T. ECTOMYCORRHIZAE APPLICATIONS

Commercial Inoculum Availability

Mycelium inoculum.--During 1982, commercial P.t. mycelium inoculum (Mycorrhiz) was available from Abbott Laboratories, Chicago, Ill., on a custom order basis. The cost was \$16 per liter (about 1 quart) and was marketed with a moneyback guarantee. About 750 to 1,000 conifer seedlings (25 to 30 per square foot) were inoculated per liter of inoculum. Based on a tree plantation spacing of 6 x 10 feet, with 726 trees per acre, the use of treated seedlings raises plantation establishment costs by \$11 to \$15 per acre.

^{1/} National Mycorrhizae Applications Coordinator, Forest Pest Management Staff, Southern Region, Asheville, NC; and Director, Institute for Mycorrhizal Research and Development, Southeastern Forest Experiment Station, Athens, GA. Both are with the USDA Forest Service.

The future availability of MycoRhiz P.t. inoculum from Abbott Laboratories is questionable, primarily because of recurrent inoculum production problems and adverse economic conditions. The company is evaluating this issue and will soon decide on future plans. The Forest Service is now exploring other sources of commercial P.t. inoculum. Plans are in progress for cooperative nursery field tests of the Butler County Mushroom Farms' P.t. inoculum by that company and the Forest Service's Southeastern Forest Experiment Station and the Southern Region in 1983.

Spore-encapsulated seed.--An alternative P.t. nursery inoculation technique involves the spore-encapsulated seed treatment available on a custom order basis from International Tree Seed Co., Birmingham, Ala. This technique was developed in cooperation with the Institute for Mycorrhizal Research and Development (IMRD), USDA Forest Service, Athens, Ga. Results obtained from several P.t. spore-encapsulated seed nursery field tests conducted by IMRD during the past three years show considerable promise for the use of this technique in certain bareroot nurseries. The Edwards State Nursery in North Carolina has 300,000+ eastern white, loblolly, and Virginia pines custom inoculated with the P.t. spore-encapsulated seed treatment by International Tree Seed Co. for the Crescent Land and Timber Corp. International Tree Seed Co. also produces a P.t. spore pellet that is being field tested by IMRD as yet another technique.

Ectomycorrhizal Inoculum Applicator - Nursery Seeder

The applicator gave good results on several pine seedling species during the past 3 years (Conn, Cordell, and Marx, 1980; Cordell and others, 1981). This unique machine has produced practical, operational, bareroot nursery seedbed inoculations using commercial P.t. vegetative inoculum. A commercial P.t. inoculum applicator is available from R. A. Whitfield Forestry Manufacturing Co., Mableton, Ga. The applicator costs \$4,500 and is designed either for separate or simultaneous use with conventional nursery seeders. During the spring of 1982, operational P.t. machine inoculations were made in 12 nurseries on six species of pines and over 1 million seedlings. These P.t. custom-tailored seedlings will be used on specific field planting sites, such as mine land reclamation and selected problem site forestation.

Future Applications

Reclamation sites.--The potential use of P.t. ectomycorrhizae in mine land reclamation has received accelerated interest and effort during the past 2 years (Wolf, Cordell, and Keller, 1982). Two nurseries in Vallonia, Ind., and Marietta, Ohio have scheduled more than 333,000 P.t. inoculated seedlings for reclamation site outplantings in southern Ohio. Pine species include Virginia (Pinus virginiana), eastern white (P. strobus), red (P. resinosa), and pitchlolly (Pitch - P. rigida X loblolly - P. taeda hybrid). Outplantings were established on eight abandoned coal mine sites in southern Ohio during the spring of 1982. Virginia pine survival varied among the sites, and was severely affected by adverse environmental factors (post-planting extended drought) and grass competition. Results obtained from four outplanting sites established by the Ohio Division of Mine Land Reclamation showed an average survival increase of 24 percent for P.t. inoculated Virginia pine seedlings over uninoculated seedlings after 1 month in the field (unpublished data).

Forestation sites.--During the past 2 to 3 years, considerable interest has been expressed by a number of private industries and others about the use of P.t. ectomycorrhizae on selected field forestation sites in the southern and central United States. For example, 10 of the 12 operational P.t. ectomycorrhizal inoculations established with either P.t. mycelium inoculum or spore-encapsulated seed treatments in 10 southern nurseries in 1982 were scheduled for forestation plantings. International Paper Co., Union Camp Corp., Champion International Corp., and Crown Zellerbach Co. recently made substantial commitments to the P.t. ectomycorrhizae applications program. In addition, the Wayne-Hoosier National Forest in Ohio and Indiana and the Savannah River Forest Station in South Carolina, along with the Georgia Forestry Commission and Ohio Division of Forestry, have made similar commitments.

Over 50 P.t. ectomycorrhizal outplantings have been established with over 12 species of conifers in some 20 States. Most of these outplantings have been established since 1979 and, consequently, tree survival and growth results are preliminary. However, outplantings with several conifer species in widespread locations show significant increases in tree survival and early growth on P.t. nursery-inoculated trees, compared to uninoculated check trees. A significant increase (25+ percent) in survival or growth is also still being observed on eastern white, loblolly, and Virginia pines after 8 years in western North Carolina. These results are very encouraging and further emphasize the potential forestation benefits and application of the previous results reported by Marx and others (1977). Similar outplantings with pine seedlings obtained from the 1982 operational nursery inoculations are scheduled for the 1982-83 planting season. All outplantings are scheduled for a 10-year duration.

DISCUSSION

Forest tree nursery and field planting results continue to be encouraging for the effective, practical use of P.t. ectomycorrhizae for custom seedling production. Nursery seedbed and container inoculations with this inoculum have repeatedly provided significant increases in seedling quality (nursery cull reduction), along with increased tree survival and growth in field plantings.

The need for quality, tailored nursery seedlings for successful field forestation and disturbed site reclamation by Federal, State, industry, and private forest land managers is becoming increasingly apparent. Although seedling costs represent a minor portion of forestation expense, seedling quality is perhaps the most significant factor in successful forestation. Consequently, a cost-benefit analysis of producing P.t. ectomycorrhizal seedlings for selected forestation and reclamation sites may be favorable in many cases when considering the total forestation and reclamation site expenses and the probable tree survival and growth benefits derived from these higher-quality, tailored seedlings. The recent emphasis on forestation nationwide, specifically in the South, to meet anticipated wood product demands in the future also places added attention on nursery seedling quality, as well as quantity. Certain ectomycorrhizal fungi have also demonstrated protection against some root disease fungi on southern pine seedling hosts in controlled research studies (Marx, 1973).

CONCLUSIONS

The operational use of P.t. ectomycorrhizae in container and bareroot tree nurseries, field forestation, and reclamation sites is progressing rapidly. Several alternative types of P.t. inoculum are available, along with effective, practical techniques for nursery seedbed inoculations. Major emphasis is on the production of P.t. tailored seedlings for specific sites, selected tree species, and related high-value forest products. Artificial nursery seedbed and container P.t. inoculations represent another potentially effective and practical nursery management tool.

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