Research Note

ECTOMYCORRHIZAL FUNGUS INOCULATIONS OF ESTABLISHED RESIDENTIAL TREES

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Trees growing in forest soils have abundant mycorrhizae. This association increases nutrient and water absorption, increase tolerance to stresses, decreases root disease and is, therefore, important in maintenance of forest health and vigor (1). Certain species of ectomy-corrhizae improve survival and growth of pine and oak seedlings on clear-cut reforestation sites, on forestation sites in the tropics, and on adverse sites, such as coal mined lands and borrow pits (2). The application of mycorrhizal technology in forestry and mine reclamation is at the commercial level.

Recently, a preliminary study showed that the fine roots and ectomycorrhizal development were significantly increased by inoculation with spores of *Pisolithus tinctorius* (Pt) on 25 to 46 cm caliper (10 to 18 in.) northern red oak (*Quercus rubra*) trees growing on a man-made landscape in Michigan (3). There is an obvious need to further test the application of mycorrhizal fungi on established landscape trees. The purpose of this project was to determine if inoculations with spores of Pt alone or in combination with slow release nitrogen fertilizer, would improve the density or development of fine roots and ectomycorrhizae on established residential trees. A secondary goal was to determine if there was significant supplantation of the naturally-occurring ectomycorrhizae on treated trees.

Methods

Plots consisted of three mature willow oaks (*Quercus phellos*), one northern red oak (*Q. rubra*), and one pecan (*Carya illinoinensis*) in an abandoned but maintained neighborhood near the Charlotte Douglas Airport, Charlotte, North Carolina. All trees were surrounded by turf. Trunk diameter at 1.3 m (4.5 ft.) above the ground line ranged from 56 to 71 cm (22 in. to 28 in.). Soil was a clay loam with pH ranging from 5.1 to 7.1.

Treatments consisted of the following soil injections:

1. *MycorTree*™ *Pt Injectable* at a rate of 114 g per 378 l (1/4 lb. per 100 gal.) of water
2. *MycorTree*™ *Pt Injectable* at the same rate plus *Bartlett Boost*® (28-9-9) at a rate of 18 kg per 378 l (40 lbs. per 100 gal.) of water
3. *Bartlett Boost*® (28-9-9) slow release fertilizer at a rate of 18 kg per 378 l (40 lbs. per 100 gallons) of water
4. Water control

Quadrants beneath the dripline of each tree were randomly assigned to each treatment. Injections were made to a depth of 20 cm (8 in.) on a 0.9 m by 0.9 m (3 ft. by 3 ft.) spacing. Injection pressure was 10 bars (150 psi) and 1.9 l (0.5 gal.) of the treatment solution was injected into each hole. Application rates were 2.7 kg (6 lbs.) of nitrogen, 0.9 kg (2 lbs.) of P_2O_5, 0.9 kg (2 lbs.) of K_2O, and 2.7 billion spores of *P. tinctorius* per 90 sq. m (1000 sq. ft.). Injection holes were marked with color coded flags to indicate location of treatment. Treatments were made March 13, 1995.

Root Ingrowth Cores (RICs) were installed March 16, 1995 to monitor new root development (4). RICs are 7.6 cm (3 in.) diameter by 20 cm (8 in.) deep plastic screen cages which allow ingrowth of roots. They were filled with root-free, treated soil, and were located within 15 cm (6 in.) of an injection site.

Roundup® herbicide was applied periodically to the treatment area to eliminate grass root contamination. Five RICs per treatment were

Table 1. Average Fine root dry weights, expressed in grams per cubic foot of soil, four and seven months after treatment.

Treatment	Pecan 4	Pecan 7	Willow Oak 4	Willow Oak 7	Red Oak 4	Red Oak 7
MycorTree Pt	15 ab*	22b	9 ab	19a	15 a	11a
MycorTree plus Boost	22 ab	48a	8 ab	35a	14 ab	10a
Bartlett Boost (28-9-9)	24 a	16b	14 a	11b	8 b	5a
Water Control	2 b	11b	2 b	9b	0.6 c	1a

*Means followed by same letter do not significantly differ (p=.05 Duncan's Multiple Range Test).

removed four months after treatment on July 18 and seven months after treatment on October 23, 1995. Soil was separated from the roots via dry screening and washing. The percentages of each root sample colonized by *P. tinctorius* and naturally-occurring ectomycorrhizal fungi was visually estimated on October 24, 1995. *P. tinctorius* is morphologically distinct with a mustard yellow color, pitted mantle and many yellow hyphal strands. Roots were dried for two days at 50°C and weighed to determine the amount of fine root growth into each RIC.

Results and Discussion

Fertilizer, *MycorTree™ Pt Injectable* and the combination of the two, all produced a significant and rapid increase in fine root growth and ectomycorrhizal development as compared to the control treatment (Table 1).

Both treatments that contained Pt did produce a slight but consistent suppression in the development of naturally-occurring ectomycorrhizae (Table 2). However, the total amount of ectomycorrhizae was greatly increased following application of Pt. Ectomycorrhizae, whether they be natural or from inoculation, increased on two of the three tree species when fertilizer was applied. The control treatment had the lowest levels of mycorrhizae development and the lowest amount of new fine root growth.

The combined increase in fine root density and ectomycorrhizae colonization rates should improve water and nutrient absorption. This in turn should result in healthier trees, more capable of tolerating the effects of drought, root disease and low soil fertility.

Although the scope of this study was limited, in field operations, application of mycorrhizae should be considered as a potential alternative to fertilizer to stimulate fine root and ectomycorrhizae development, where natural mycorrhizae are suppressed due to poor soil conditions. Inoculations can also be considered in sensitive areas such as near surface water, on young trees where rapid top growth should not be encouraged, on trees in confined growing space, in "all natural" programs, and on trees with root disease, especially those caused by *Phytophthora.* Additional research is required to confirm these recommendations.

Literature Cited

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Table 2. Average mycorrhizal colonization rates seven months after treatment. Numbers are percent ectomycorrhizal colonization from *Pisolithus tinctorius* (Pt) or other naturally occurring ectomycorrhizae (Nat), and the combination of the two (Tot).

Treatment	Species								
	Pecan			Willow Oak			Red Oak		
	Pt	Nat	Tot	Pt	Nat	Tot	Pt	Nat	Tot
MycorTree Pt	43a*	16a	59ab	43a	27b	70a	39a	26a	65ab
MycorTree plus Boost	59a	24a	83a	46a	26b	72a	45a	25a	70a
Bartlett Boost (28-9-9)	0b	36a	36b	0.4b	49a	50b	0 b	45a	45b
Water Control	0b	49a	49b	0.3b	42a	42b	0 b	22a	22c

*Means followed by same letter do not significantly differ (p=.05 Duncan's Multiple Range Test).

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Résumé. Des arbres déjà bien établis en milieu résidentiel ont été inoculés avec des spores d'ectomycorhizes et fertilisés. Les résultats suggèrent que l'inoculation seule ou l'inoculation avec fertilisation permet d'accroître la densité en fines radicelles ainsi que le développement ectomicycorhizien par rapport à des arbres non traités.

Zussammenfassung. In Wohngebieten wurden Bäume mit abgeschlossener Herstellung mit den Sporen von Ectomycorhiza-Pilzen inokuliert und anschließend gedüngt. Die Ergebnisse verdeutlichen, daß die Inokulation ohne und mit Dünger im Vergleich mit unbehandelten Bäumen die Feinwurzeldichte und die Entwichlung von Ectomycorhiza erhöht.