Twenty Years Later – Revisiting A Jack Pine Mycorrhizae Study Near Raith, Ontario

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Introduction

Potential for ectomycorrhizae to enhance the survival and growth of boreal tree seedlings, especially container grown stock, has been the subject of much research over the past 25 years. This presentation focuses on the work done as part of my Master of Science in Forestry research program in the late 1970s. Partners in the project were the Institute for Mycorrhizal Research and Development (IMRD), a division of the USDA, and the Ontario Ministry of Natural Resources, specifically the Thunder Bay Forest Tree Nursery. The project involved a field trial of two sources of inoculum of *Pisolithus tinctorius* (Pers.) Coker and Couch (*Pt*) and two fertilization regimes. In the late 1970s, when this project was initiated, there was a great deal of interest in this particular fungal symbiont and trials were being established across the United States and, in this case, in northern Ontario. *Pt* has a documented history of enhancing tree survival and growth particularly on very disturbed sites such as mine tailings (Marx *et al*. 2002).

Methods and Results

Original study – Jack pine seedlings were inoculated with *Pt* from two sources (IMRD and Abbott Laboratories) at three different ratios of inoculum to growing media (1:30, 1:15 and 1:7.5). Over a four-month growing period, seedlings received either a full "F" fertilization schedule (32 mg nitrogen (N), 10.5 mg phosphorous (P), 19 mg potassium (K)) or a nominally half "1/2 F" fertilization schedule (20 mg N, 6 mg P, 12 mg K). Seedlings were assessed for physical (height, weight, root collar diameter) and chemical (total N, P, K) characteristics as well as for ectomycorrhizal development. The latter was confirmed by IMRD (see Marx *et al*. 1982). Detailed results of the assessment are found in Phillips (1981). In summary, inoculated seedlings on the lower fertilizer regime were smaller but formed more ectomycorrhizae, nutrient (N, P, K) concentrations were lower and contents were higher for mycorrhizal seedlings; combined with generally higher dry weights, this suggested greater growth efficiencies for the mycorrhizal seedlings (Marx *et al*. 1982).

A field trial, approximately 100 km north of Raith, ON, was established in July 1978 (Fig. 1). Four replications of 49 seedlings each (approximately 1 m by 1 m spacing) were established using an RCB design. The site, classified as Site Class 2 jack pine (Plonski 1981) had been harvested in the mid-1970s, used as a landing as late as 1977 and scarified in 1978. Soil was a well-drained, deep sandy loam. Measurements were made in the late summer of 1979 after one full growing season. At that time *Pt* ectomycorrhizal seedlings exhibited better growth (total height, height increment, total dry weight, RCD) than the un-inoculated counterparts; fully fertilized seedlings generally did better than ½ F seedlings; consistently, the smallest seedlings were C, ½ F (un-inoculated, reduced fertilizer) (see Fig. 2). There was no difference in seedling survival (mean at 90%). Although *Pt* was isolated from the roots, it was not an aggressive competitor; colonization of all outplanted seedlings by native fungi was apparent within one year. The conclusion at the time was that *Pt's* main effect had been to promote rooting in the first growing season (Navratil *et al*. 1981).

Figure 1: *Location of the jack pine* Pisolithus tinctorius *field trial, established in 1978 in northwestern Ontario.*

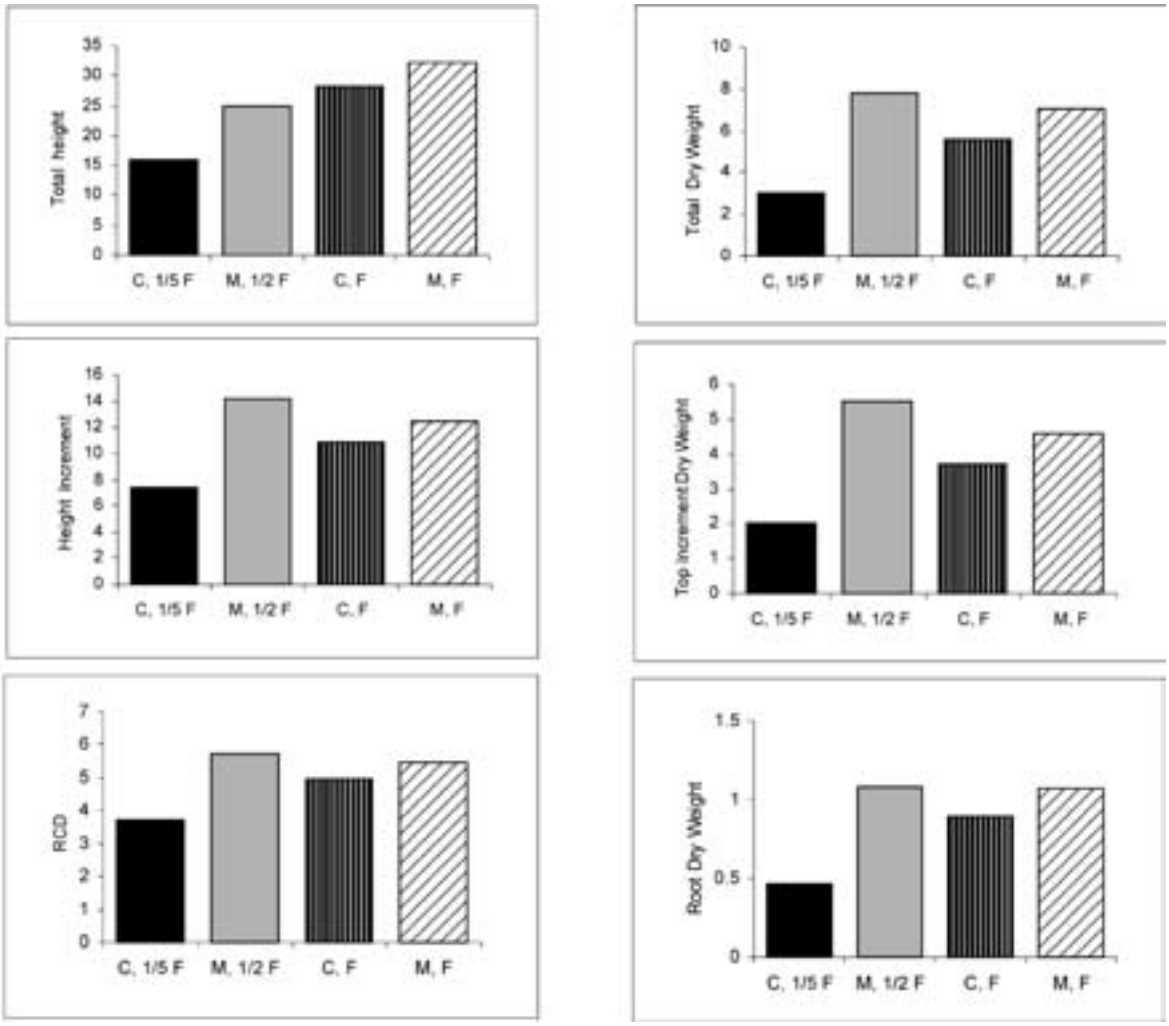

Figure 2: *Physical parameters of outplanted jack pine seedlings measured in the late summer of 1979. Height (cm), RCD (mm), Dry Weights (g). C – Control, M – Mycorrhizal, F – full fertilization, ½ F – Reduced fertilization*

In the summer of 1999, we located the original study and re-measured all the plots. We decided to concentrate on the four treatment groups that had been selected by Navratil *et al.* (1981). These were the un-inoculated controls ("C") and the USDA 1:15 ("M") seedlings raised at Full ("F") and half Full ("1/2 F") fertilization. There was no difference in survival (mean of 75%), total height (from 9.8 to 10.8 m) or DBH (8.4 to 10.6 cm). Tree size was highly variable. We decided to use a stem analysis approach to determine if the original differences had persisted after outplanting; we also designed a study to determine if *Pt* had survived in the plots. These studies were undertaken by undergraduate students as their thesis projects. Bennett (2000) selected trees randomly to represent average growth and Stickel (2001) selected from the largest trees to represent potential of the treatments. Both used a series of selection rules to reduce the effect of uneven competition. Nutrient analysis of the soil and foliage (total carbon, N, sulphur plus a range of cations) from a random selection of trees was completed in the fall of 2003.

Stem analysis utilizes a detailed dissection of whole tree stems in order to map out the height and diameter growth over time. Volumes of stem sections were then calculated using Smalian's formula (Husch *et al.* 1982); the tree tip was treated as a cone.

Present and historical volumes (dm^3) for the average and largest trees are shown in Fig. 3 and 4, respectively. Based on average tree size, the fully fertilized, mycorrhizal (M, F) trees were consistently and significantly the smallest. There were no differences between the mean volumes of the largest trees.

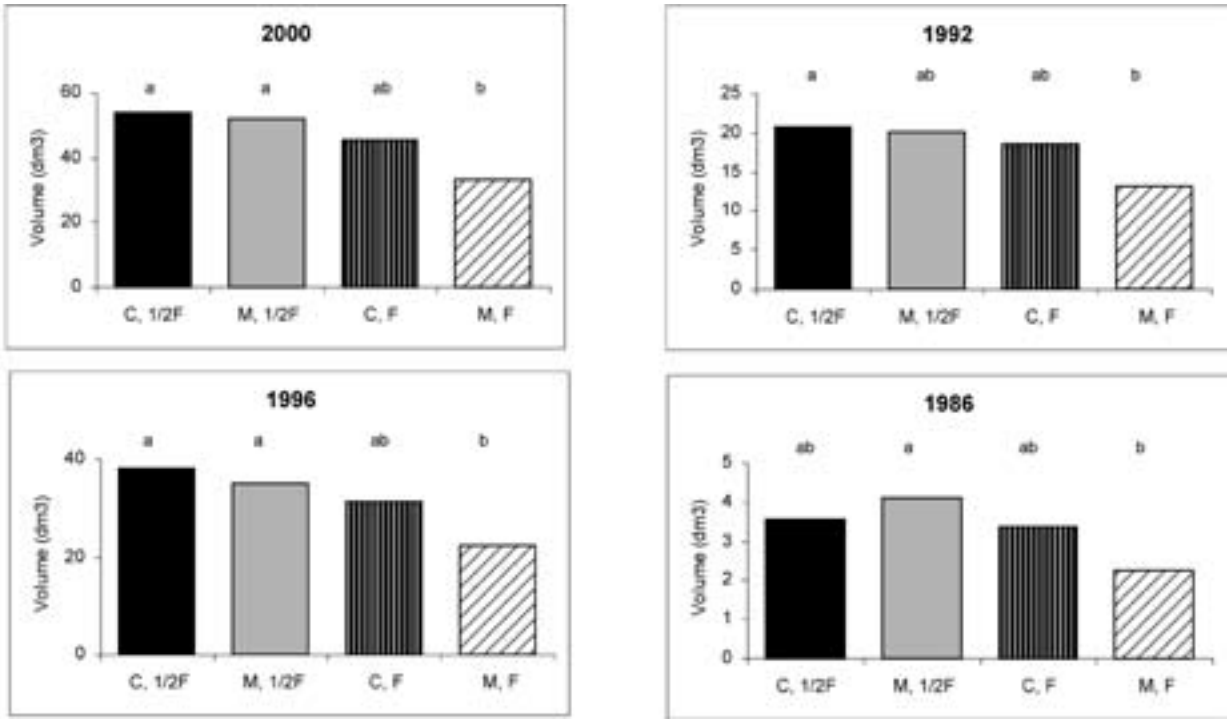

Figure 3: *Present and historical mean volumes (dm^3) of average jack pine trees established in 1978. C – Control, M – Mycorrhizal, F – Full fertilization, ½ F – Reduced fertilization. Bars with different letters are significantly different at p = 0.05.*

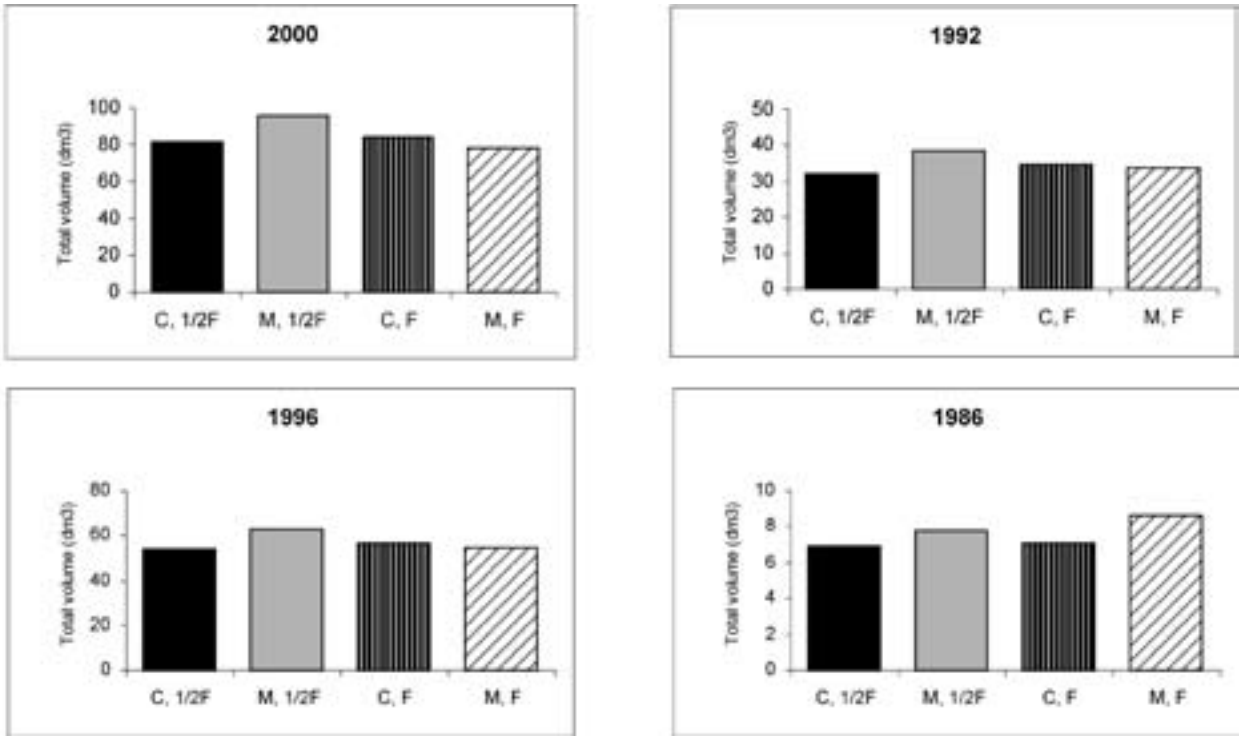

Figure 4: *Present and historical mean volumes (dm^3) of the largest jack pine trees established in 1978. C – Control, M – Mycorrhizal, F – Full fertilization, ½ F – Reduced fertilization. No significant differences among treatments.*

van Straaten (2000) used a variety of techniques but was unable to isolate *Pt* from the ectomycorrhizal short roots of selected jack pine trees. Nutrient analyses of both soil and foliage showed no difference between treatments.

Conclusions

- Initial differences didn't translate into long term differences
- Control seedlings did just as well, if not better, than inoculated seedlings
- All trees exhibited some form of ectomycorrhizae; *Pt* wasn't isolated from any of the selected trees therefore not a strong competitor
- *Pt* may still be appropriate for severely disturbed sites
- Reinforces importance of matching site with tree and (native?) mycorrhizal species

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