


# MYCORRHIZAE IN CONSERVATION NURSERY PRODUCTION

CULTURAL TECHNIQUES, PRACTICES, AND TOOLS AT THE INTERVALE  
CONSERVATION NURSERY



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# Cultural Techniques, Practices, and Tools for Bare Root Production

- ▶ Mycorrhizal inoculation is a cultural technique we combine with other tools as part of developing a system for nursery production that is more ecologically sustainable and resilient. The other tools in our system include:
  - primary tillage with a spader (minimal till/subsoiling)
  - Lundeby plant lifter (harvest implement)
  - cover cropping
  - ramial wood chip mulch

# GOALS



- **BUILDING OF A PLANT-SOIL-MICROBE COMMUNITY:** part of a resilient and sustainable nursery production system that can provide a substantial amount of our fertility requirements.
- **REDUCING APPLIED NITROGEN:** experimenting with applying mycorrhizal inoculant together with soluble sources of nitrogen (N) from fish emulsion and kelp extracts as catalysts for soil microbial populations to convert available N into microbial (amino/protein) N that is more readily taken up by the plants in a living soil web.
- **REDUCING TILLAGE:** A current hypothesis is that reduced soil disturbance slows decomposition of soil carbon, which increases soil C sequestration.
  - Peterson (1998) describes soil cultivation as stimulating soil carbon (C) loss and thereby accelerating oxidation of soil C by microbial activity. Jackson (2003) addresses short-term changes due to “tillage perturbation,” suggesting that impacts on soil quality proceed rapidly.

## Types of Mycorrhizae in Native Tree Production

*Endomycorrhizae* (also referred to as arbuscular) — This fungus penetrates the tree's root cells. Trees that utilize this type of mycorrhizae: ash, walnut, maple, sycamore, some poplars and conifers

*Ectomycorrhizae* — This fungus surrounds the tree's roots rather than penetrating them. Trees that utilize this type of mycorrhizae include hickory, alder, beech, oak, fir, pine, and spruce.

*Thelephora terrestris* is an *ectomycorrhizae* species that occurs naturally and is commonly found in bareroot nursery beds. This species is well-adapted to the precise growing conditions of nursery beds, but is not commonly found in reforestation sites.



## Mycorrhizae in Tree Propagation

- May stimulate the growth of fine roots, speeding the tree's growth, and lengthening the life of the root system.
- When the tree's root system is extended due to mycorrhizal extensions this helps promote more vigorous growth and tolerance to environmental stresses.
- There may be a benefit to the tree's immune system, making it more resistant to soil borne pathogens and parasites.
- Mycorrhizal fungi can also assist the tree in competition with surrounding grasses for nutrients and water..
- High fertilization rates have been known to suppress mycorrhizae development, particularly when the fertilizer is high in phosphorus (> than 150 ppm).



# Mycorrhizal Inoculant Product



- ▶ 4 species Endomycorrhizae
  - ▶ *Glomus aggregatum*
  - ▶ *Glomus etunicatum*
  - ▶ *Glomus intraradices*
  - ▶ *Glomus mosseae*
- ▶ 7 species Ectomycorrhizae
  - ▶ *Pisolithus tinctorius*
  - ▶ *Rhizopogon amylopogon*
  - ▶ *Rhizopogon fulvigleba*
  - ▶ *Rhizopogon luteolus*
  - ▶ *Rhizopogon villosulus*
  - ▶ *Scleroderma cepa*
  - ▶ *Scleroderma citrinum*

## RAMIAL WOOD CHIP MULCH

- Derived from tree branches up to about 7cm in diameter because the proportion of essential twig nutrients in wood chips increases as average branch diameter decreases.
- When uncomposted ramial wood chips are used as mulch, complex fungal systems prevalent in forest soils do most of the decomposing.
- Ramial wood is the tree's "factory" for producing wood, lignin, polysaccharides, oxides and proteins, providing an important source of nutrients and energy for plant and soil life.
- Nitrogen, phosphorus, potassium, calcium, and magnesium are found in the green cambium where leaf photosynthesis and root nutrition come together. By applying ramial mulch, we can redirect this process to build more resilient soil for producing bare root trees.



## *Size of the branches being chipped matters for impact on soil microbial life.*

- Carbon-to-nitrogen ratios in ramial-diameter wood averages 30:1, going no higher than 170:1 at larger diameter end of the recommended branch.
  - By comparison, ratios are higher in tree stem wood, running 400:1 to as much as 750:1, thereby creating the soil dynamic where nitrogen becomes unavailable to the plant until such "log mulch" has significantly been broken down.
- Accumulation of acid-rich organic matter as humus results from the decomposition of ramial wood chips because soil fungi are adept at creating humus from a lignin source.
  - Soil that has been built from the top down through fungal action undergoes *humic stabilization* creating maximum nutrient recycling in the soil and soil structure that is being managed by soil organisms.
- Fungal hyphae physically bind soil particles together, creating stable aggregates that help increase water infiltration and the soil's water holding capacity.



## SPADER FOR PRIMARY TILLAGE

- The motion of a set of mechanical shovels work in a single pass to eliminate compaction into the subsoil and prepares the soil for planting by loosening the soil without disruption to the soil profile or diminishment of topsoil.
- This tillage practice promotes water percolation and retention and stronger root penetration.
- This form of primary tillage minimizes disturbance to the mycorrhizal network because it doesn't cut up the mycelium.



## SPADER + LUNDEBY PLANT LIFTER

- A spader is our primary tillage tool because it is matched to the subsoiling and soil loosening action of our Lundeby Plant Lifter harvest implement.
- This enhances the soil environment for superior tree root development.



## The Future: Research Needs

- Forest tree nurseries need more information on the interactions of mycorrhizae, cover crops, tree species, and application timing in a rotational cropping system for managing tree seedlings dependent on arbuscular mycorrhizae.
- ICN is experimenting with common cover crops in 1- to 2-year rotations to help boost arbuscular mycorrhizae populations while increasing soil organic matter.
- It is our hope that the potential of mycorrhizae to positively affect tree seedling survival and growth will continue to draw research efforts at using cultural techniques to produce a superior mycorrhizal seedling.
- A better understanding of the mycorrhizal system for each nursery, tree species, and outplanting site is needed to determine the cultural or artificial inoculation practices. Ultimately, any practices used in forest nurseries should increase seedling performance and have an acceptable benefit-to-cost ratio.

Thank you, questions are welcome.

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