EQUIPMENT, PRODUCTS, AND SERVICES

The purpose of this section is to make readers aware of new equipment, products, or services that might help them in their work. All trade names mentioned are used for the information and convenience of the reader, and so not imply endorsement or preferential treatment by the author or the USDA Forest Service.

Timing of mycorrhizal inoculation—I frequently get asked my opinion on the need for inoculating seedlings with mycorrhizal fungi. Mycorrhizae has been a popular topic in nurseries for many years and there seems to be a variety of opinions. Some "true believers" feel that mycorrhizae are essential for all phases of nursery culture as well as outplanting whereas others arc more skeptical. My own position is somewhere in-between.

Most nursery managers are either unsure about whether their seedlings have mycorrhizae or have no idea of which organisms are involved. A mycorrhiza is the anatomical structure resulting from the symbiotic association between a plant root and a fungus. There are two main types that are distinguished by their morphology: ectomycorrhizae (ECM) and endomycorrhizae-which are more correctly known as vesicular-arbuscular mycorrhizae (VAM). What type is present at a nursery will depend on what species of seedlings are being grown. ECM are the mycorrhizae that are most often noticed in forest and conservation nurseries because of their mushroom fruiting bodies or the colored sheath of fungal hyphae with surrounding mycelia can be seen with a hand lens on the short feeder roots (Figure 1).

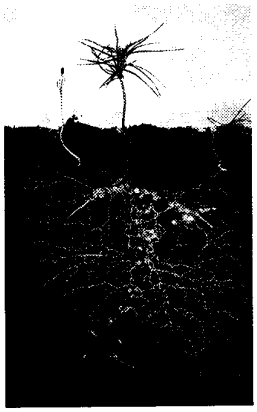

Figure 1

When considering inoculation with mycorrhizal fungi, growers should think about what they hope to gain. The benefits of mycorrhizae can be separated into nursery effects and outplanting effects. The experience at many nurseries has been that high-quality crops can be grown without mycorrhizal inoculation because the nursery environment supplies all the growth requirements of a seedling. The other major nursery benefit of mycorrhizae is protection against root pathogens but, with a sterile growing medium and containers, these pests should not be much of a problem in container nurseries. In bareroot nurseries, however, mycorrhizal can protect against fungal pests. One of the most widely advertised benefits of mycorrhizae is increased survival and growth on afforestation sites. And, of course, one of the most important benefits is from a marketing standpoint because seedlings with well-developed mycorrhizae are widely considered to be high-quality nursery stock.

The most recent development in the field of mycorrhizae has been how and when to inoculate. ECM fungal spores can be applied to seeds before sowing, or vegetative inoculum of ECM or VAM fungi can be incorporated into soil or growing media before the crop is sown. ECM fungal spores can also be applied in a water suspension either by hand, or through the existing irrigation system starting as soon as seedlings have enough roots

for successful colonization. Many nursery cultural practices, especially high fertilization rates, inhibit development of mycorrhizae and so inoculating during the hardening phase with its lower N fertilization has some merit. The drawback is that roots may already be infected with other mycorrhizal fungi, especially the ubiquitous T. terrestris, which thrives in the nursery environment.

If you'd like to try some inoculum in your nursery, I've prepared a listing of the current sources of mycorrhizal inoculum (Table 1). Note that they vary in what type of fungi they contain. Some products contain ECM or VAM fungi, some have a single species, and some are mixtures. Another notable difference is the formulation. All the current products involve spores which can be in granular, tablets, liquid or packet formulations. Finally, the method and timing of application varies considerably. As previously mentioned, make sure the application timing corresponds to your reasons for inoculating in the first place. If you are primarily interested in outplanting effects, then a root dip application might make more sense than an incorporation into the soil or growing medium. As with all such listings, I'm sure that there are some products that I've missed or some of the information may have changed. Let me know and, if possible, we will upload this information onto our home page and try to keep it current.

Table 1—*Commercial sources of mycorrhizal fungi for inoculating seedlings*

Product	Type of Mycorrhizal Fungi [1]	Type of Inoculum	Method and timing of Application
Biogrow Tree Tabs PO Box 108 West Linn, OR 97608 TEL: 503.638.4804 FAX: 503.638.2901	Mixture of 5 species of ECM fungi + enhancers	Spores in tablet form	Apply to soil or growing media during sowing, transplanting, or outplanting
Biogrow Blend? (Same as above)	Mixture of ECM fungi + enhancers	Spores in liquid form	Apply manually or inject into irrigation system
Bio/Organics? 3200 Corte Malpaso #107 Camarillo, CA 93012 TEL: 805.388.0910	Mixture of VAM fungi	Spores in granular form	Incorporate into soil or growing media during sowing or transplanting
Myco-Pak RTI USA 875 Airport Road, #R Monterey, CA 94940 TEL: 800.784.4769 FAX: 408.372.6753 E-MAIL: neila@redshift.com WEB: http://www.reforest.com	VAM fungus	Spore pellets in packets	Apply to soil during outplanting
MycorTree? Root Dip Plant Health Care 440 William Pitt Way Pittsburgh, PA 15238	Mixture of ECM and VAM fungi + biostimulants	Spores in granular form	Making slurry and dip roots prior to transplanting or outplanting
VAM 80 Tree of Life Nursery 33201 Omega Highway PO Box 635 San Juan Capistrano, CA 92693 TEL: 714.728.0685 FAX: 714.728.0509 E-MAIL: tstjohn@cosmoaccess.net WEB: www.mycorrhiza.com	VAM fungus	Spores in granular form	Incorporate into soil or growing media during sowing or transplanting
Forest Mycorrhizal Application PO Box 1181 Grants Pass, OR 97526 TEL: 541.476.3985 FAX: 541.476.1581 E-MAIL: info@mycorrhizae.com	Site specific ECM fungi	Spores in liquid form	Apply to nursery crops in irrigation or use as a root dip before outplanting

[1]ECM = Ectomycorrhizae; VAM = vesicular-arbuscular mycorrhizae