



Turning a New Leaf Conference
Shepherdstown, West Virginia
November 16, 2013

Track D: Soil Science Simplified

Session D.1 The Hidden World of Mycorrhizal Fungi. Dr. Roger Tai-Koide, Emeritus Professor of Horticulture, Penn State University

Mycorrhizae are a symbiosis between a fungus and plant root. The term was coined by A.B. Frank who discovered the symbiosis studying truffles. 75-80% of terrestrial plants are mycorrhizal. Fungi are considered a separate kingdom from plants and animals but they are eukaryotes. Bock's Herbal in 1552 considered them to be mostly moisture from decaying vegetation and Linnaeus considered them a mysterious form of plant in the 18th century. Yeast are single-celled fungi but mycelial fungi are multi-cellular. Fungi are important in the production of food and drink, biofuels and antibiotics and pharmaceuticals and they are decomposers important to nutrient cycling. Fungi form symbioses with algae, bacteria and plants.

Fungal hyphae absorb water, nutrients and minerals from the soil and transport it to the root cells. The plant in turn provides carbon to the fungus. Nitrogen is often limited in soils, and fungi will provide first for themselves, only supplying a plant if there is excess. Phosphorus is an important nutrient transferred by the fungi to the plant.

Ectomycorrhizae (EM) form a thin mantle of tissue around the plant root. Most ectomycorrhizal fungi form sporocarps, or fruiting bodies, that produce spores. The spores are tiny and wind-dispersed. There are relatively few species of plants that are EM, but they are often ecologically dominant species in some places such as in boreal forests and Eucalyptus forests. Birch, oak, beech and pines are examples of EM trees. Porcini and truffles are examples of mushrooms produced by EM fungi. EM tree seedlings have improved growth if soils are inoculated with EM fungi in plantations.

Arbuscular mycorrhizae (AM) grow inside root cells forming arbuscules (tree-like shapes) in the cell surrounded by the host cell's membrane. They form naked spores that store oil. These spores are much larger than the tiny spores produced by EM and to move from place to place soil or plant roots would need to be moved. Most herbaceous plants (including crop plants) are AM. Cherry, redbud, maples, dogwoods and tulip poplars are examples of AM trees. Winter cover crops can help keep mycorrhizae in farm fields alive and increase crop productivity. In long fallow disease, mycorrhizal fungi die and crops are stunted.

Non-mycorrhizal plant families include the Brassicaceae, Proteaceae, Carophyllaceae, Crassulaceae, Cyperaceae, Juncaceae, and Chenodiaceae. In a study comparing corn grown after soybeans versus canola, canola reduced yield of the corn crop. Brassicas also release allelopathic chemicals that could be reducing yield. Most non-mycorrhizal plants have adaptations to help obtain nutrients. The Proteaceae have special roots with large surface area and they secrete organic acids that help obtain nutrients. Brassicaceae secrete acids when P is deficient.

Several companies now grow mycorrhizae but production is expensive. Companies listed include Mycorrhizal Applications, Fungi Perfecti, Plant Health Care, and Premier Horticulture. There are also many companies that are essentially selling fertilizer labeled as mycorrhizae. The products can be useful in some limited



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circumstances, for example where topsoil was removed or if there has been severe soil disturbance. If vegetation is already growing somewhere, then applications probably won't help and added mycorrhizae would probably be outcompeted by the ones already present. Fungi are native to certain habitats and non-native in others, so you also want to be careful about introducing them to new areas. It is possible to make your own inoculums.

Q&A

Q. What about pathogens?

A. Not all are fungi, some are oomycetes. Fungicides active against oomycetes may not kill true fungi.

Q. Tilling?

A. Can be very destructive if the soil is tilled finely (such as rototilling). Tilling that leaves large clods of soil will still leave intact mycorrhizae. Cover crops that are tilled in are probably fine because the roots are tilled into the soil.

Q. Herbicides?

A. Very little research has been done on whether herbicides affect mycorrhizae. Fungicides are often not effective against AM. He is currently studying effects of pesticide coated seeds on soil microorganisms. The pesticides also float into the air during planting and could affect other insects.

Q. Soils stored for long periods of time?

A. Inoculum will die in the center of a pile.

Q. Are mycorrhizae present in compost?

A. No, not if compost was from a hot pile.

Q. How specialized are fungi?

A. AM show little host-specificity. EM have all degrees of specificity but the plants are not as specific about which fungi they associate with.

Q. Is there a way to encourage the mycorrhizae in disturbed soils?

A. Usually just takes time unless you are using subsoil in which case you could add inoculums.

Q. Soilless potting mixes used in container grown stock?

Q. No mycorrhizae in these soils and they probably wouldn't grow well in them anyway since they need mineral soils. Soilless mixes are essentially a hydroponic system so the grower is providing the nutrients.