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Technical Bulletin

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MYCORRHIZAL FUNGAL INOCULUM: NOT ALL PROPAGULES ARE SPORES

Mycorrhizal fungal inoculum is any material that can produce mycorrhizal fungal colonization on absorbing roots of plants. The fungal components that produce this colonization are called “propagules”. Even forest soil has been used historically as mycorrhizal fungal inoculum (called “forest soil inoculum”), since it contains so many naturally occurring mycorrhizal fungal propagules. However, soil is notoriously impure, carrying beneficial as well as disease-causing organisms. For practical reasons, of course, soil cannot be used commercially as an inoculum product because it must be clean and free of pathogens. Soil inoculum can contain potentially damaging organisms and weeds.

Mycorrhizal Fungal Propagules

There are several fungal components that are commonly used commercially as VA mycorrhizal (VAM) fungal propagules. These include spores, colonized root fragments, and dry fungal mycelium from the root zone. There is considerable difference in the effectiveness over time of each of these types of propagules.

Root Fragments and Mycelium Fragments

Colonized root fragment propagules are nothing but plant roots containing VAM fungal mycelia. In the production of some brands of commercial VAM inoculum, these roots are removed from the plant and soil, dried, diced up into small pieces, and mixed into a dry carrier. Mycorrhizal fragments and dried mycelium fragments are effective propagules as long as they are reasonably fresh. As they age, their effectiveness is rapidly lost as the fungi on the dried root fragments gradually die during prolonged routine storage. Spores are longer-lived, and therefore, are better for commercial products.

Spores

Spores are actually reproductive and survival structures produced by the mycorrhizal fungi. Ectomycorrhizal fungi produce fruiting bodies, usually above ground, such as mushrooms or puffballs. These fruiting bodies produce billions of airborne spores. VAM fungi produce spores underground on roots in the soil. Usually, VAM fungal spores grow singly at the ends of hyphal strands, and are typically produced outside of the root (but there are exceptions). The spores near roots germinate and colonize new roots, thereby propagating the fungal species. Spores are much more long-lived than root fragments and other propagules. Ectomycorrhizal fungus spores, like

Pisolithus or *Scleroderma*, can remain viable for 10 years or more in routine storage. VAM fungal spores, however, typically last 2 to 3 years at room temperatures, if handled properly.

Three Viability Types of VAM Fungal Inoculum

Based on the types of propagules and the manner of processing, some companies recognize three viability types of inoculum: Green Inoculum, Dry Inoculum, and Spore Inoculum.

Green Inoculum is composed of very moist, freshly harvested roots and growing medium containing all types of propagules. While this type of inoculum is very infectious, the shelf life is about 30 days. This makes it useless for large-scale commercial applications. Green Inoculum is the type commonly produced and used by researchers.

Dry Inoculum is green inoculum that has been slowly dried. About 35 to 50% of the propagules are still viable (that is, 50 to 65% of the propagules have died). Early reports on the shelf life of Dry Inoculum rated it as about 90 days if stored in a cool, dry place. While this is a significant improvement over the shelf life of Green Inoculum, it is still unacceptable for commercial products. There are some indications that this has been extended, but root fragment inoculum is still not considered to be as long-lasting as spore inoculum.

Spore Inoculum is composed of VAM fungal spores. Spores require more time to colonize roots, but they have a prolonged shelf life of at least 3 years with proper storage. Plant Health Care, Inc. lists a shelf life of 2-3 years on most VAM fungal spore products, to allow for production time and inventory time.

Measuring the “Strength” of Commercial Inoculum

The “strength” of commercial mycorrhizal fungal inoculum is measured by the number of propagules capable of colonizing roots. Unless the type of propagule is specified, this measurement is misleading, because root and mycelial fragments lose their viability much more quickly than spores. Therefore, a product containing 5000 dried root or mycelial fragments per pound would be inferior from a commercial standpoint to one containing 5000 spores per pound. The shelf life of root and mycelial fragments (whether “green” or dried) is rather short for commercial use, because commercial products require several months for production inventory time, as well as distributor inventory storage, and end user storage. By the time the root fragments and mycelial fragments reach the field, many may have died.

PHC, Inc. Counts only Spores

Plant Health Care, Inc. has always used spores as the propagule for our standard inoculum products.* Spore counts on Plant Health Care, Inc. products, mean exactly that: SPORES. Plant Health Care, Inc. does not count root fragments or mycelia as spores.

Some Companies Count All Propagules

Some companies have been listing their inoculum strength by showing the number of “propagules”. This included spores, root fragments, and dried mycelium. However, in response to advisories by PHC, Inc. staff and scientific circles, the word is getting out that spores are the propagules of choice for commercial mycorrhizal fungal inoculum. It appears that many companies may have merely changed the wording on their labels and technical literature. Now, they are calling all propagules “spores”, when in fact, only a fraction of the number they list are actually spores.

All Propagules Are Not Spores

Spores are the inoculum propagule of choice, but all propagules are not spores. It is important to understand this.

Spore Production in Mixed vs. Pure Culture

According to discussions in on-line mycorrhizal news groups, the overriding assumption is that some producers of VAM propagule mixtures produce the cocktail by inoculating the same plant host with several species of VAM fungi at once, with the hope that all VAM fungi will grow equally and contribute equally to the inoculum. The producers then list all VAM fungi species without concern over the proportions of each.

Plant Health Care, Inc. takes exception to this approach. What usually happens in mixed cultures is that one or two species take over the host, and overwhelmingly dominate the culture. So instead of buying a 5 or 6 species cocktail as the label suggests, you are really getting a 1 or 2 species cocktail, with perhaps an occasional spore of the other species which were originally added.

To overcome this problem, Plant Health Care, Inc. produces VAM inoculum in by inoculating our production host plants with a single species of VAM fungus. To produce our 4-species cocktail, the spores of each individual fungus species are harvested from separate pot cultures, and the spore numbers are determined for each batch. Then, the batches are mixed in proper proportions so that the spores of each species are represented in equal numbers.

With Plant Health Care, Inc., there are no tricks. We declare four species because we deliver four species. Some other brands declare four or more species because they started the production batch with four or more species, even though they did nothing to ensure that each VAM fungus species would successfully grow and produce significant numbers of spores.
