Mycorrhizae and Turfgrass: Looking below the surface of turf management

Myco-What?

Ten years ago the mention of mycorrhizal fungi to a turf manager might have met with a blank stare. Today's managers are much more knowledgeable regarding the benefits of mycorrhizae. Research studies have shown us all how these specialized fungi can improve fertilizer utilization, rooting depth, establishment, and drought resistance of turf. New tools, such as the use of beneficial mycorrhizal fungi, allow turf managers to improve the condition of both turf and soil.

What are Mycorrhizae?

In their undisturbed natural environments, most grass species form a beneficial association with mycorrhizal fungi. The resulting structure is called a mycorrhiza, literally meaning "fungus-root." Although there are several types of mycorrhizal fungi forming mycorrhizae with plants, the largest group, endomycorrhiza (also called arbuscular mycorrhizae) form with most grass species. Mycorrhizal fungi are present in soil as spores, and hyphae (filaments) in soil or as colonized roots.

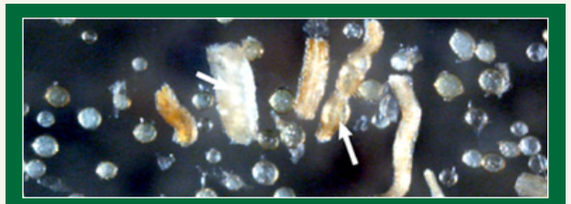

Figure 1. Glomus spores and colonized root with spores (arrows) from MycoApply® inoculum.

Once the mycorrhizal association is established, it provides increased root surface area to support the exchange of nutrients between the fungus and the grass. These filaments form an extensive system that grows into the surrounding soil, providing numerous and various benefits for the grass plants. This network of filaments efficiently absorbs water and 15 major macro and micro nutrients, transporting these materials back to the turf root system and into the host plant. Mycorrhizae are especially important for the uptake of nitrogen and phosphorus as well as many hard-to-acquire micro nutrients. Conserving water and delivering fertility directly into the target turf grass is a key goal of turf managers. The mycorrhizal network improves water and nutrient utilization, which minimizes off-site groundwater movement of fertilizer. It also binds soil particles together which improves soil porosity and enhances the movement of air and water within the soil.

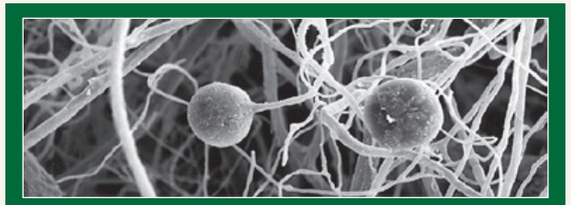

Figure 2. The elaborate network of hyphae beneath the soil surface greatly increases the potential of the root system to access nutrients and water.

Mycorrhizae: Where are they?

Soils in natural settings are full of beneficial soil organisms including mycorrhizal fungi. However, research indicates that many common landscape practices such as site preparation, grading, removal of natural vegetation and heavy use of chemical pesticides and fertilizers often degrade the mycorrhiza-forming potential of soil. Construction site preparation activities such as removal of topsoil, compaction, erosion and simply leaving soils bare can also reduce or eliminate healthy and diverse populations of mycorrhizal fungi (Amaranthus et al. 1996; Doer et al. 1984; Dumroese et al. 1998, Amaranthus and Steinfeld 2003, Rider et al. 2007).

Figure 3. Site preparation eliminates populations of beneficial mycorrhizal fungi.

Research shows that putting greens constructed according to U.S. Golf Association standards generally lack mycorrhizal fungi at the time of sowing and that mycorrhizal populations are slow to establish in the greens (Koske et al. 1997, Hartin et al. 2007). Furthermore, laboratory analyses of root samples from hundreds of turf grass areas across the U.S. indicate that the majority have less than 20 percent mycorrhizal colonization. Many samples were found to have no mycorrhizal colonization at all. New mycorrhizal products designed for the turf grass industry are now restoring these ancient grass allies back to impacted soils.

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Mycorrhizae and Turfgrass: Why They Are Right For Me!

Show Me the Data

Mycorrhizae are, by far, the most researched aspect of soil biology. Over sixty thousand studies of the mycorrhizal relationship with plants are available in the scientific literature. Studies have shown that grass species in the family Poaceae benefit greatly from mycorrhizal colonization in terms of growth and nutrient acquisition (Gemma and Koske 1989; Sylvia and Burks 1988; Hall et al 1984, Rider et al. 2007). Warm-season grasses such as bermuda grass with coarse root systems are particularly dependent upon mycorrhiza for sustained growth (Hetrick et al 1988; 1990). Recent data indicates that cool-season, finer rooted bentgrass species also form abundant mycorrhiza and benefit from the relationship, especially in soils in which the phosphorus levels are moderate or low (Gemma et al. 1995; Gemma et al 1997; Koske et al 1997). Recent findings of improved turf grass establishment, root growth, fertilizer utilization, coverage has encouraged many turf managers to include mycorrhizal inoculations in their construction and maintenance practices (Hartin et al 2005, Rider et al. 2007). Turf areas often incur environmental stresses caused by compaction, frequent mowing, and artificial sandy substrates lacking nutrient and water holding capacities. The benefits of mycorrhizal inoculation are especially apparent in such high-stress situations.

Water, Water Everywhere?

Water conservation awareness has increased as water becomes an increasingly expensive and environmentally sensitive component of turf management. Research has shown that mycorrhizae can reduce moisture stress in grasses (Koske et al 1995; Auge et al. 1995; Allen et. al. 1991). Studies published in Journal of Turfgrass Science state that creeping bentgrass inoculated with mycorrhizal fungus tolerated drought conditions significantly longer than non-mycorrhizal turf (Gemma et al. 1997). Mycorrhizal-inoculated turf also recovered from drought- induced wilting more quickly than non-mycorrhizal turf. The data also shows that mycorrhizal turf maintained significantly higher (avg. 29% more) chlorophyll concentrations than non-mycorrhizal turf during drought events.

Figure 4. Creeping Bentgrass cover with mycorrhizal inoculation (Right) and cover in control Area (Left). Courtesy of Robert Green PhD research argonomist, University of California

Faster Growth and Root Development

Research (Gemma et al, 1997; Hartin et al. 2005, Rider et al. 2007) indicates that mycorrhizal inoculation at the time of sowing turfgrass can increase its rate of establishment. This quick establishment of turfgrass in sandy soils has attracted the attention of golf course maintenance managers because faster establishment and earlier playability has a significant economic payback. Other recent trials in Oregon and California demonstrated that mycorrhizal inoculants applied at the time of sowing doubled the percent of grass cover in the early establishment period and significantly increased the root biomass of treated turf.

**Full references to this article are available at www.mycorrhizae.com.*

Figure 5. Grass root development with MycoApply® inoculation (top) and no inoculation (bottom).

Reduce Nutrient Loss and Pollution

Only a fraction of the synthetic fertilizers placed in U.S. soils are utilized by plants as intended. Much of these applied materials result in the movement of nutrients into groundwater or waterways and end up damaging the surrounding environment. Some is volatized into the air, contributing to acid rain and climate change, while much of it travels past the root zone of the target plants, through the soil profile and into groundwater and neighboring streams, lakes and oceans.

Phosphorus is a nutrient that is essential to aquatic plant growth. Phosphorus pollution accelerates a process called eutrophication, which is essentially the biological death to a body of water due to depleted oxygen. When aquatic plants, such as algae, absorb an abundance of phosphorus, they can grow out of control.

Figure 6. Green Algae

One pound of phosphorus can result in the growth of 350-700 lbs. of green algae! Excess amounts of phosphorus and nitrogen cause rapid growth of phytoplankton, or algae, creating dense populations, or blooms. The algae ultimately sink and are decomposed by bacteria, depleting the bottom waters of oxygen. Like humans, most aquatic species require oxygen. When the oxygen in deep water is gone, fish and other species will die unless they move away to areas of suitable habitat. On the economic side, excessive algal growth due to nutrient pollution increases water treatment costs, degrades fishing, boating activities, and can impact tourism, property values and even human health.

Soil biology is critical to capturing and storing fertility in the ground (Read et al. 1992). An acre of healthy topsoil can support an immense array of living organisms and the associated web of life that assimilates and captures long-term fertility (Amaranthus et. al 1989). It is clear that utilizing biological amendments is a necessary paradigm shift for the utilization and conservation of soil nutrients that is available to managers today.

When to Use Mycorrhizae?

Turf areas are generally devoid of mycorrhizal populations following construction and site preparation (Gemma et al 1997, Hartin et al. 2005, Rider et al. 2007) and are prime candidates for achieving the benefits of the mycorrhizal inoculation. The inoculum can be incorporated during construction, by aerification, or "over the top", if soils are porous and enough water is available to leach the mycorrhizal spores into the soil profile. This places the mycorrhizal propagules in the rooting zone where they will be effectively utilized. A good time to apply the inoculum is when roots are most active such as spring and fall. Mycorrhizal colonization assessments are simple tests that are now available at many soil testing laboratories (go to www.mycorrhizae.com for more info on mycorrhizal fungi and their practical application).

Use Diverse Species of Mycorrhizal Fungi

Natural areas generally contain an array of mycorrhizal fungal species. Not all mycorrhizal fungi have the same capacities and tolerances. Because of the wide variety of soil, climatic, and biotic conditions characterizing turf environments, it is improbable that a single mycorrhizal fungus could benefit all turf grasses and adapt to all conditions. Mycorrhizal fungi species have varying abilities to protect turf against drought. Likewise, some mycorrhizal fungi are better at producing enzymes that facilitate mineral uptake such as phosphorus and iron. Still other mycorrhizal fungi can better access organic forms of nitrogen. Selecting mycorrhizal products containing several mycorrhizal species can provide a range of benefits to the plant not found with only one species.

Figure 7. An array of spores showing different mycorrhizal Glomus species

Making a Commitment

How often do you think about the impact of your management practices on turf and environmental quality? Annually? Weekly? Daily? If you responded weekly or daily you are probably a person who is interested in environmentally-friendly products that will improve turf and soil quality. Mycorrhizal fungi are not new, trendy, genetically engineered organisms. These specialized fungi have been fundamental to the survival and growth of plants for over 400 million years.

Scientific advancements in the culture of certain beneficial mycorrhizal species are rapidly creating more cost-effective mycorrhizal products to the turf management marketplace. Mycorrhizae can help lower costs over the long run. A living soil and healthy turf will retain nutrients, build soil structure, reduce stress and minimize certain maintenance activities. The appropriate use of mycorrhizae in turf programs will not only benefit the environment but will also improve coverage, rooting, fertilizer utilization and drought resistance. Protecting the environment has never made more sense. Myco-what? This is definitely a question of the past.

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