WTA Field Day 2010:
Can Mycorrhizae Replace Phosphorus Fertilization?

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What are mycorrhizae and why are they important?

As water and fertilizer costs and regulations continue to increase, a number of agronomists and horticulturists are seeking ways to reduce the need for both inputs. Mycorrhizae are a group of fungi that infect plant roots without causing disease: the association between plant and fungus is deemed symbiotic, that is, beneficial to both the plant and fungus. A number of studies show mycorrhizae can enhance drought stress and/or recovery and extract nutrients such as nitrogen and phosphorus from soil for their host plants (Augé 2001; Javaid, 2009).

The plant roots provide a "home" for the fungi, which normally cannot grow without being associated with the plant. The plants benefit the mycorrhizae by providing them with carbon produced from photosynthesis. One study with Sheeps fescue *(Festuca ovina)* showed uninfected plants transferred only 10% of their carbon from leaves to roots, while plants infected with mycorrhizae transferred a whopping 36% of carbon fixed by photosynthesis to the plant roots (Graves et al., 1997). While the mycorrhizae likely used much of the extra carbon, some of the carbon surely must be used for root growth, too, as mycorrhizae infection can increase root mass. In most cases, however, the plants are able to compensate for this carbon "loss" by increasing their photosynthetic efficiency, which in fact may be enhanced by mycorrhizae positively affecting plant functions such as the opening and closing of leaf pores (Augé, 2001). Plants infected by mycorrhizae develop longer, finer roots which increase their ability to absorb water and nutrients. The increased water and

nutrients cause plants to grow larger, and probably faster, than non-infected plants.

Turfgrasses and mycorrhizae

Many cool-season grass species are capable of being highly colonized by mycorrhizae. At one Polish site, 40-95% of the roots of Kentucky bluegrass, hard fescue, red fescue, and tall fescue were highly colonized (Ryszka and, 2007). Colonization may be dependent on the grass variety: in the same study, colonization of perennial ryegrass was zero for one variety and high for another variety.

Pelletier and Dionne (2004) inoculated a lawn mixture of KBG, red fescue and perennial ryegrass with several rates of five species of mycorrhizae. They found slightly faster establishment (~10%) with some of the mycorrhizae inoculations, however, all roots were colonized to about the same extent even in the uninoculated plots. The experiment was done on a silt loam soil, though, which likely already had a large number of mycorrhizae spores. In sand-based root zones, for which the sand was dug from a pit, spores may be relatively absent or missing. One survey showed older sand-based putting greens had more spores than one or two year-old greens, with up to seven different mycorrhiza species present in greens older than two years (Koske et al., 1997a). They surmised the putting greens were either "contaminated" with soil during construction or entered the greens from the collars which were constructed of native soils, and the mycorrhizae fungi increased over time. Another survey of creeping bentgrass, velvet bentgrass, and *Poa annua* greens revealed 18 species of mycorrhizae, with the greatest amount of spores in creeping bentgrass and the least amount in *P. annua* putting greens (Koske et al., 1997b). The authors found the amount of mycorrhizae spores increased during the growing season and decreased during the winter, indicating a strong dependence on plant growth.

Besides the benefits already discussed, mycorrhizae may help turf managers in other ways. An English study showed inoculation of putting greens with mycorrhizae spores reduced *Microdochium* patch (i.e., pink snow mold; Gange and Case, 2003). If mycorrhizae can provide reasonable biocontrol of snow mold diseases, the impact could be tremendous in a state like Wisconsin where fungicides are essential for controlling the disease yet federal regulations make the future of fungicide use questionable. In another study,

putting greens had significantly less *P. annua* as the amount of mycorrhizae increased (Gange et al., 1999). The authors hypothesized that either the mycorrhizae were directly antagonistic to *P. annua*, or the mycorrhizae were more beneficial to creeping bentgrass. The work by Koske et al. (1997b) suggests the latter phenomenon, though a definitive study to show the mechanism of *Poa* control has not been done. A series of greenhouse and mini-plot studies from Rhode Island showed mycorrhizae could enhance drought stress, recovery from drought stress, and suggested some protection could be conferred against take-all patch disease of creeping bentgrass (Koske et al., 1995). The same group also noted that frequent application of P-containing solutions helped mycorrhizae colonization of bentgrasses, while too little or too high of P concentrations reduced mycorrhizae.

Mycorrhizae putting green plots at the WTA/UW-Madison Turfgrass Field Day

Because phosphorus fertilization has become such a contentious issue in Wisconsin, we have decided to see what the impact of phosphorus fertilization and mycorrhizae inoculation have on putting greens. We established creeping bentgrass and velvet bentgrass plots on a USGA-sand mixture in late summer of 2009 at the O.J. Noer Turfgrass Research and Educational Facility. Half of each plot was inoculated with mycorrhizae at the time of establishment, half was not (Fig. 1). The project is supported by the Robert F. Newman Wisconsin Distinguished Graduate Fellowship, which was developed by the Wisconsin Turfgrass Association (WTA) in conjunction with the UW-Madison Graduate School. The graduate student supported by the project, Rebekah Verbeten, is studying the effects of mycorrhizae and pH relationships on bentgrasses and low input turfs. In the field project to be shown at this summer's field day, we've been collecting information on the relative establishment rate and degree of mycorrhizae colonization at four pre-plant P rates (0, 1, 2, and 4 lb P/1000 ft^2) for both creeping and velvet bentgrasses. We'll repeat the study again this year and next to confirm our results. If you're curious to see for yourself, come visit us at the WTA/UW Turfgrass Field Day, Tuesday July 27.

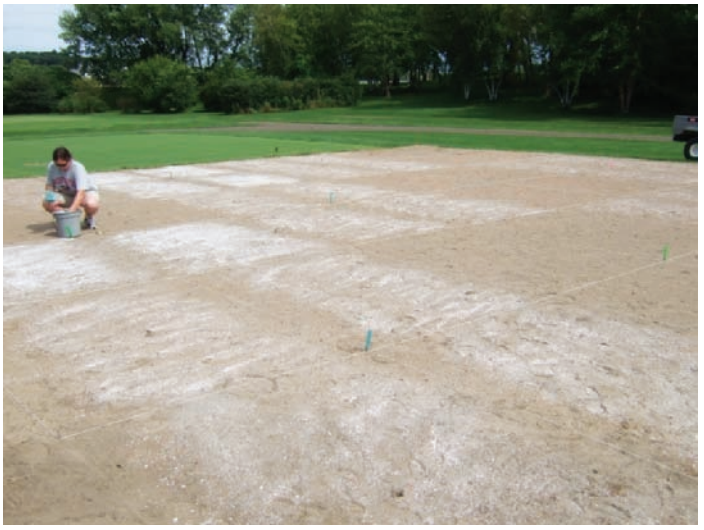

Fig. 1. Application of putting green root zone with phosphorus and mycorrhizae spores at the O.J. Noer Turfgrass Research and Educational Facility, August 2009.

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