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MYCORRHIZAL FUNGI BENEFIT PUTTING GREENS

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ENDOPHYTIC microorganisms occur in most species of plants as inhabitants of above- or below-ground organs. Their presence in the tissues either elicits no apparent effect in the normal functioning of the infected plants, or the endophytic may confer various benefits to the host. Grasses are no exception and present intriguing examples of these associations that can have application in turf management.

Fungi are the most frequently encountered partners with grasses, and several species that colonize leaves and stems are now known to confer protection from herbivores and environmental stresses. These properties are being exploited for turfgrass species, where resistance to depredation from surface-feeding insects is a major benefit. Unfortunately, these fungi do not inhabit root tissues, but, as in most plant roots, grass roots harbor other endophytic fungi, in particular, many species of vesicular-arbuscular mycorrhizal (VAM) fungi can be found. VAM endophytes have been extensively documented, and their beneficial effects on growth and development of a range of plant species have been demonstrated. However, the species involved and their biology and impact in the turf environment have received only cursory examination. In fact, there is a common belief that VAM fungi are of little importance in highly maintained turf where the extensive fine root system of the grasses receives ample water and nutrients that eliminate the requirement for the symbiosis. With the generous support of the USGA, a research project to investigate the subject of VAM in turf-grasses commenced at URI in 1990.

We sampled turf throughout New England and performed a variety of greenhouse and field trials to assess the incidence and importance of VAM fungi in golf greens. Our efforts were focused on creeping bent-grass (*Agrostis palustris* cv Penncross) and velvet bent-grass (*Agrostis canina* cv Kingstown). Initially, we needed to determine how frequently the fungi occurred in association with these turfs and what species of fungi were involved.

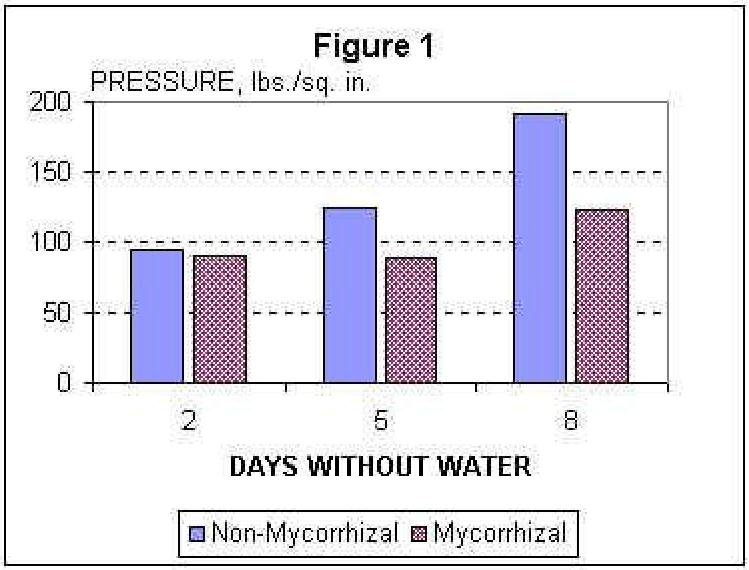
In our four-year study we found 29 species of VAM fungi occurring with these bent-grass, several of which were new species. None of the species have previously been studied for any particular impact on bent-grass turf, yet virtually every one of the more than 200 root zone samples examined contained VAM fungi.

We performed numerous growth experiments where bent-grass were inoculated with different species of VAM fungi. All experiments were carried out in a medium meeting USGA Green Section specifications for sand greens. The fungi were added to the mix before seeding. The fungus that we used most frequently was *Glomus intraradices*, the only species for which sufficient inoculum was commercially available. Results of inoculation were striking. Establishment of young turf was enhanced by inoculation with mycorrhizal fungi, and differences were apparent within three weeks after seeding. Turfs older by several months continued to grow more vigorously with Mycorrhizae. In addition to improved growth, mycorrhizal turf was greener than non-mycorrhizal turf and possessed up to 60% more chlorophyll.

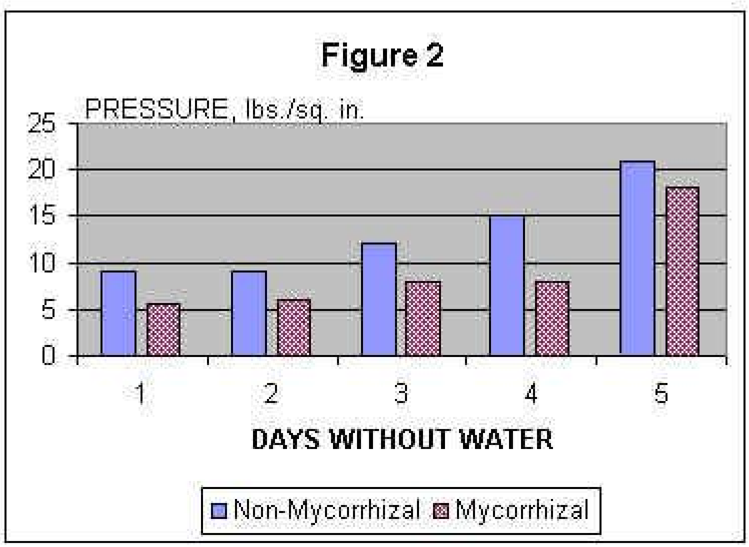
Phosphorus fertilization rate affected how well the VAM fungi performed. The most vigorous mycorrhizal turfs were those that received frequent applications of a low-P fertilizer solution. When the P concentration was too high or too low, Mycorrhizae did not enhance growth.

Mycorrhizal fungi are sensitive to a range of pesticides (e.g., Benlate, Aliette, Phaltan, Diazinon), and the benefits to turf may thus be lost temporarily if suppressive materials are applied.

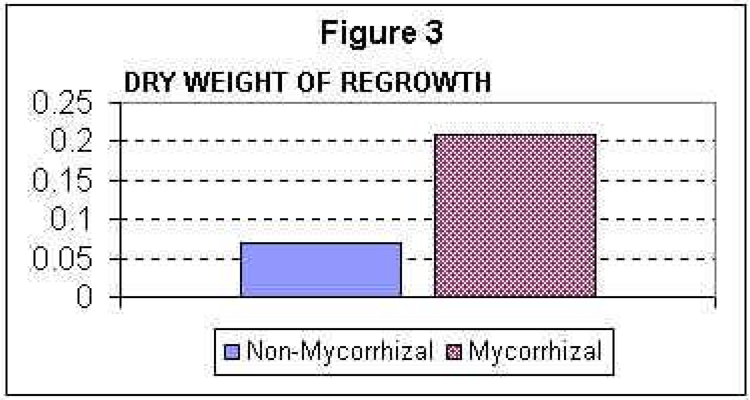
In both field mini-plots and greenhouse trials in pots, mycorrhizal turf of Penncross survived drought conditions far better than did non-mycorrhizal turf. After a five-day drought, mycorrhizal turf in the field study showed 39% less water stress than did control turf, and after eight days, the difference was 60% (Figure 1).



In the greenhouse study, turf without mycorrhizae began wilting after three days, but mycorrhizal plants were wilted only after five days (Figure 2).



Mycorrhizal turfs also recovered more rapidly, producing three times as much leaf matter as the controls (Figure 3).



Preliminary trials indicated that mycorrhizae may provide some protection against the take-all fungus *Gaeumannomyces graminis*. As noted in the growth trials, however, this benefit was present only when P concentration was moderately low. At higher levels of P mycorrhizal turfs tended to be susceptible to take-all.

Conclusions

The presence of mycorrhizal fungi in putting greens constructed according to USGA Green Section specifications offers potential benefits to the turf. Improved drought tolerance and related rapid recovery from wilting appear to be the most significant, but increased growth and establishment rates, greater chlorophyll content, and a lowered phosphorus requirement are also worthy of note. A probable result of these benefits may be manifested in an increase in resistance of mycorrhizal turf to foot traffic (wear), although this was not measured in our results.

During our four-year investigation of mycorrhizal fungi in greens turf, we made several discoveries that were not the main object of our study, but have importance to the practical use of Mycorrhizal fungi in greens. First, mycorrhizal fungi naturally colonize new greens turf without being added as inoculum. While inoculation of a new green at the time of seeding is likely to result in a more rapid establishment of the green, in the longer term it may not be necessary. We examined a variety of one to four-year-old greens where VAM fungi had not been intentionally inoculated, and in most of them the turf roots were already highly mycorrhizal. It is not clear how the fungi arrived in the root zone of these greens. Spores of VAM fungi are relatively large and are formed underground. Thus, they should not move readily into non-mycorrhizal situations (e.g., sand/peat greens) unless as soil-borne inoculum. It seems likely that the VAM fungi that were found in these greens were present in soil that was deliberately added to or contaminated the sand/peat medium during green construction, or the fungi invaded the green from the adjacent native soils. The VAM fungi are ubiquitous in soils but generally are absent from clean sand and peat.

The ease with which the VAM fungi invade new greens may be just as well because commercially available inoculum is not yet readily available. Premier Peat, Quebec, Canada does offer a limited supply of Mycori-Mix, a product that contains *Glomus intraradices*. As we learn more of the biology of these fungi, it appears that selected effective species or biotypes may be incorporated into greens during construction. A protocol may be determined so that established greens can be managed to obtain the full benefits of the symbiotic association. More effective VAM species are likely to be found than the ones that invade by chance, and these may be matched to particular turfgrass species or cultivars for specific climate and growing conditions.

Ultimately, it may prove to be biologically, environmentally, and economically feasible to use mycorrhizal fungi in putting greens to reduce requirements for fertilizer and water while achieving a greener, more vigorous, disease-resistant turf.