Fungicide application effects on non-target microbial populations of putting greens

Researchers at Cornell University tested the hypothesis that repeated applications of fungicides to putting greens would have major impacts on microbial populations of both foliar and soil-borne microbes. Surprisingly, this was not that case.

The management of turfgrasses, especially on golf courses, represents perhaps the highest level of plant management practiced on any agricultural or horticultural commodity known today. Proper turfgrass management involves a number of rather complicated mechanical, physical, chemical, and biological manipulations that result in the desired product of a blight-free carpet of green grass. Highly maintained turfgrass sites characteristically use high inputs in the form of fuel, fertilisers, pesticides, and water for irrigation. Pesticide use, in particular, is substantial with the use of fungicides a major tactic for controlling diseases on high quality turfgrasses. This is particularly true on golf greens.

Short cutting heights, the ever-increasing amount of traffic on putting greens, and low nutrient inputs have placed unprecedented stresses on turfgrass plants, making them highly susceptible to damage from many different diseases, some of which were previously considered relatively unimportant. Golf course turfgrasses receive very high fungicide and use is increasing (1).

The majority of those applications are to putting greens and tees, making the amount of fungicide applied per unit area quite high. Since many high-maintenance turfgrass sites are found in close proximity to surface waters and within critical groundwater recharge areas, and primarily in and around urban areas, questions have been raised as to the impact of such a land use on water quality, wildlife, and human health, particularly as it relates to pesticide exposures.

Further, there have been a number of non-target effects of fungicides in turfgrass management systems. These include selection of fungicide-resistant biotypes of pathogens, promotion of non-target diseases, enhanced thatch build-up, decreased root or stem biomass and rapid disease resurgence following fungicide applications (5).

Given the high levels of fungicides applied to turfgrass, we considered it likely that high levels of applications of frequently applied fungicides would alter or perturb soil and foliar microbial communities. This perturbation is an expected to have significant consequences including the promotion of non-target diseases and rapid disease resurgence because of the destruction of natural antagonists of turf pathogens. This paper summarises three years of extensive sampling of turf microbial communities in the presence and absence of fungicide applications.

MATERIALS AND METHODS

In 1996, five eight-foot diameter ‘swimming pool’ greens constructed in 1995 at the Cornell University Turf Research Farm in Ithaca, NY were used as the experimental microplots. The pools contained the standard USGA sand/peat profile.

Subplots consisted of an untreated plot and the seven fungicide treatments. Each subplot was three square feet and each treatment was represented on each pool. The fungicides selected represent different classes and have significant effects on turf. Prostar 50WP flutolanil 85g/93m² 14 days

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Active Ingredient</th>
<th>Rate*</th>
<th>Application Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostar 50WP flutolanil 85g/93m²</td>
<td>14 days</td>
<td></td>
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<tr>
<td>Banner Maxx (proiconazole)</td>
<td>113g/93m²</td>
<td>21 days</td>
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<tr>
<td>Chipco 26019 Flo iprodione 226g/93m²</td>
<td>21 days</td>
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<tr>
<td>Bayleton 25W triadimeton 113g/93m²</td>
<td>21 days</td>
<td></td>
<td></td>
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<tr>
<td>Sentinel oymiconazole 0.7g/93m²</td>
<td>21 days</td>
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* All fungicides were applied at the rate specified in the table above. All applications were made with a hydraulic sprayer. The plots were divided into subplots to test the efficacy of different fungicides.

In 1996, we sampled roots from the plots every month and evaluated changes in the microbial profiles using the various media. We detected no significant differences and the results were similar to those in 1997, so we will present only the 1997 data. Similarly, we found no significant differences in BIODIOG microbial metabolic profiling, based on principal component analyses. We also found no differences in general microbial activity or following phospoholipid activity tests. In 1997, we sampled both roots and leaves. The total number of fungal propagules detected was greater in soil at the start of the season than later, but there were no significant effects even after the season-long application of fungicides, regardless of the fungicide applied (Fig. 1). On leaves, there were no significant effects of fungicide applications on total numbers of fungi, regardless of time or fungicide application. Most of the fungicide detected was in the genus Trichodema. We were able to distinguish between species similar to T. viride and those similar to T. harzianum, since the latter has a tan pigmentation on the reverse side of the acidified potato dextrose agar plates while those of T. viride are white.
There was no significant effect of time or treatment on either Trichoderma spp. in soil, but on foliage, there were initially higher levels of T. harzianum at the start of the season. By the end of the season there were no differences between the two and fungicide applications made no difference. Likewise, the fungicide applications had no effect on foliage, there were initially higher levels of T. harzianum, but by the end of the season, other fungi had largely displaced T. harzianum, and were predominately yeasts, Penicillia and others. This was particularly true with plants that had been treated with Daconil Ultrex. On plants treated with Bayleton 25, T. harzianum remained the predominant fungus (Fig. 2).

In 1998, we performed a mini-experiment on a soil green at the Cornell University Turf Research Farm. In September and again in October we focused on the timing of sampling after application of fungicides. We sampled the plots before we made the scheduled application (day 0), one day after the application (day 1) and again seven days after the application (day 7).

FDA hydrolysis analyses and fungal enumerations were performed at each sampling time for four different treatments: untreated, Daconil Ultrex, Chipco 28019 Flo and Banner Maxx. Three replications of each treatment were sampled. For the final sample set, all treatments were sampled one day after the final fungicide application.

The relative numbers of filamentous fungi versus yeasts changed substantially on turf leaves as evidenced by both the numbers and plate appearances (Fig. 3). However, there was no significant difference in total microbial metabolic activity among fungicide treatments as measured with the FDA test. Most of the fungi isolated from leaves of untreated plants were filamentous fungi, while after the season-long application of Daconil, most of the fungi isolated were yeasts. With Chipco or Banner, the change in populations of filamentous fungi versus yeasts was more transient, dropping immediately after application and then increasing within a week.

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We were particularly surprised at the leaf plating data, which at first glance, gave little indication of change based on numbers counted on the various media. However, it now is clear that, while total numbers of fungi on leaf blades do not change, the application of fungicides changes the composition in favour of yeasts relative to filamentous fungi. This effect may be transitory, as in the case of Chipco, or longer lasting as was the case with Daconil.

The fungal community on leaf blades appears highly dynamic and changing in response to fungicide applications. It is important to note that the natural dollar spot epiphytic that occurs each year was controlled by fungicides as expected (data not shown).

ACKNOWLEDGMENTS

G. E. Harman and K. L. Onalik are from the Departments of Horticultural Sciences and Plant Pathology, Cornell University, Geneva, NY. E. B. Nelson is from the Department of Plant Pathology, Cornell University, Ithaca, NY. This research is published with the permission of USGATERO (Vol. 5, No.7).

REFERENCES