FEATURE ARTICLE

The New Generation of Fungicides of Microbial Origin

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By now, most golf course superintendents in the U.S. have applied or at least heard of the new fungicide Heritage®. What most people may not realize is that Heritage represents a new generation of fungicides, whose active ingredient was derived from a microbe. Use of natural products as fungicides, however, is not entirely new in the turfgrass market. Cycloheximide, which was sold under the trade name of Acti-dione®, was used in the 1960s and '70s on turf to control dollar spot, leaf spot and other diseases. Cycloheximide was a by-product in the production of the antibiotic streptomycin. Streptomycin was derived from the bacterium *Streptomyces griseus*. Cycloheximide was expensive to produce and could be phytotoxic to turf, thus its registration was withdrawn in 1981.

Fungicides of microbial origin can be produced by fermentation (i.e., growing large quantities of a desired microbe in an aerated vat) or the antifungal properties of the microbe can be identified and synthesized in the laboratory. Regardless of how the products are produced, they must undergo the same U.S. Environmental Protection Agency registration rigor that is required for all other pesticides.

Azoxystrobin. Heritage® represents a new class of chemistry referred to generically as beta-methoxyacrylates. The origin of the first identified compound (i.e., strobilurin A) was a fungus from the mushroom family named *Strobilurus tenacellus*. The common chemical name for Heritage® is azoxystrobin. The strobilurin-based compound was stabilized by adding molecules to the structure to ensure that it was not rapidly broken-down by solar radiation. Because the original compound was slightly changed in the laboratory, azoxystrobin is best described as a synthesized analog of a natural substance.

Heritage® can be taken up by roots and move via the xylem throughout the plant. When sprayed on leaves, it penetrates and moves through the leaf, where some molecules enter the xylem and move upward in the plant from the point of uptake. Because Heritage® only moves upward from the site of uptake, **it is not truly systemic and therefore it is best described as being an acropetal penetrant.** The fungicide provides disease control by interfering with respiration of sensitive fungal pathogens. It blocks electron transfer in the cytochrome bc complex and thus it is single site specific. That is, it only blocks one biochemical event, which means that **the probability for resistance to occur increases greatly** when compared to compounds with multi-site activity.

Heritage® is remarkably broad spectrum and is one of the few turf fungicides with a diverse target list, which includes both root and foliar pathogens as well as *Pythium* diseases. It's demonstrated target strengths include brown patch (and other *Rhizoctonia* diseases such as yellow patch and zoysia patch), summer patch, take-all patch, anthracnose, red thread, and *Helminthosporium* leaf spot. There is not a great deal of evidence, however, that it is as strongly effective against snow molds or *Pythium* diseases as it is against the aforementioned diseases. **Heritage's® greatest known weakness is dollar spot.** It

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Turfgrass Winter Stresses

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Low Temperature Stress Tolerance. Both turfgrass species and cultivars vary greatly in low temperature hardiness. Therefore on sites subject to periodic low temperature stress, **it is important to select cold hardy cultivars as well as species.** Among the cool-season turfgrass species the perennial ryegrasses (*Lolium perenne*), tall fescues (*Festuca arundinacea*), and annual bluegrasses (*Poa annua*) are typically prone to low temperature kill. In contrast, rough bluegrass (*Poa trivialis*) and creeping bentgrasses (*Agrostis stolonifera*) are excellent in low temperature stress tolerance, followed by the Kentucky bluegrasses (*Poa pratensis*).

Among the warm-season turfgrasses Japanese zoysiagrass (*Zoysia japonica*) is the best low temperature hardy species, followed by the dactylon bermudagrasses (*Cynodon dactylon*) and seashore paspalum (*Paspalum vaginatum*). Carpetgrass (*Axonopus* spp.), St. Augustinegrass (*Stenotaphrum secundatum*), and bahiagrass (*Paspalum notatum*) are very poor in low temperature tolerance. **In both the bermudagrasses and the zoysiagrasses, the vegetatively propagated cultivars as a group tend to be more low temperature tolerant.**

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not only does not control dollar spot, but it can actually enhance this disease. Hence, Heritage must be tank-mixed with another fungicide whenever dollar spot is active.

Fludioxonil. Novartis recently has registered Medallion® for use in controlling *Rhizoctonia* diseases in greenhouse crops, ornamentals and turfgrass. This fungicide also will be marketed as a pre-packaged mixture with Banner MAXX® under the trade name Foundation®. Medallion® and Foundation® will be sold under an experimental use permit in selected states in 1998. The common chemical name of Medallion® is fludioxonil. **Fludioxonil is an analog of a natural product called pyrollnitrin.** Pyrollnitrin is produced in nature by the bacterium *Pseudomonas pyrocinia*. As was the case with azoxystrobin, pyrollnitrin had to be stabilized to protect it from rapid solar radiation degradation.

Unlike azoxystrobin, **fludioxonil is a contact fungicide.** As such, its residual activity is relatively short-lived, and this is one reason why it will be offered in a prepackaged mixture with Banner MAXX®. Fludioxonil interferes with membrane transport processes in sensitive fungi. It is unclear whether this compound has single-site or multisite activity. While fludioxonil has activity on summer patch and snow molds, its strength appears to be as a brown patch and *Helminthosporium* leaf spot fungicide. Early testing indicates that fludioxonil has curative activity, but generally performs better when applied preventively. Fludioxonil is the first contact fungicide to enter the turf market in over 30 years. Another interesting aspect of this product is that **its residual activity is enhanced not only by mixing it with Banner MAXX®, but also by the plant growth regulator Primo® (trinexapac ethyl).** When Primo® is applied a few weeks prior to the application of fludioxonil, the effectiveness of the fungicide is improved. Evidently, the reduction in clippings removal accorded by the use of Primo® keeps fludioxonil on leaves longer, thereby increasing its residual effectiveness.

Polyoxins. The "polyoxins" are a class of antifungal compounds produced by the fermentation of *Streptomyces cacaoi* var. *asoensis.* Polyoxorim is a fungicide from this group (proposed trade name from PBI Gordon is STOP-IT®), which was shown to be extremely effective in controlling brown patch at remarkably low rates. The status of polyoxorim and similar compounds for use on turf is currently unknown.

Summary. Hence, turfgrass disease management strategies have been expanded to include not only the direct application biological agents, but also the development of microbial-based analogs of naturally occurring, antifungal compounds.

Winter Coloration of Warm-Season Turfgrasses

J.B Beard

Annual visits to Japan have revealed a different philosophy in terms of winter color on dormant warm-season turfed fairways. Approximately 60% of the golf courses do not winter overseed, but rather apply a colorant to their zoysiagrass fairways. Typically **colorant applications are made from 2 to 4 times during the winter dormancy period.** They find this approach to be much less costly than winter overseeding of cool-season turfgrasses with its associated costs of mowing and other cultural practices throughout the winter. Most golf course fairways in Japan are composed of manila zoysiagrass (*Zoysia matrella*), except on the northern island of Hokkaido. Colorant application is being done on golf courses with 35,000 to 50,000 rounds of golf per year involving a substantial amount of play during the winter period.

It should be noted that many Japanese golfers tend to pick the ball off the zoysiagrass fairways during their stroke, which results in minimal divoting. The strong resistance to divoting typical of zoysiagrass turfs may be one of the reasons why this approach to hitting balls from fairways is quite common in Japan. Consequently, divot openings are not as extensive as on turfs in other parts of the world. Also, golf carts are not as widely used as in the United States.

Typically, the earlier usage of colorants on winter-dormant fairways in the United States had involved a single application. Do multiple winter colorant applications have the potential for use elsewhere in the world? Is this approach effective where extensive divot openings and intense golf cart traffic are a concern? Time will tell!