You would be hard-pressed to find an informed sports turf professional or golf course superintendent today who doesn't realize the value—both agronomic and aesthetic—of topdressing his field or course religiously. What started as a cultural practice limited to golf greens has moved to fairways, athletic fields, and other large turf areas. Greater acceptance has translated to improvements in topdressing technique and technology, and spawned a host of equipment choices.

"We started building topdressers specifically for athletic fields about 10 years ago," recalls George Bannerman of Gordon Bannerman Limited, "and people were telling us were we crazy to get into that market. Turf managers were saying they really wanted a sports field topdressing unit, but hardly anyone was topdressing sports fields."

Basic Benefits

Topdressing, applying material such as sand or soil over the "top" of the turf—and ensuring it gets to the soil surface— has long made sense on golf course greens from appearance and playability standpoints. The applied material smooths uneven surfaces. However, from a turf management point of view, benefits of the practice go far beyond aesthetics. Topdressing is a powerful weapon for thatch control.

"Topdressing helps control thatch development," explains Dr. Jim Murphy of Rutgers University's Extension and Crop Science Department. "A lot of people contend that by adding soil or sand to the turf area in question, you increase its microorganism content, allowing the microbes to break down dead or dying matter. That's true to a certain extent, but the most important aspect of topdressing is that it changes the physical nature of the thatch layer. Instead of consisting of exclusively organic matter, it becomes a mix of organic matter and soil—you make the environment better for degradation [of thatch] to take place. And in changing the physical nature of the thatch layer, you change the moisture, heating, and cooling aspects of it. The fluctuations of these aspects aren't nearly as dramatic when you topdress."

The nutrient status of the thatch layer, Murphy contends, is also improved through topdressing. Often roots growing in this area have "little contact with the growing media."

"THE MOST IMPORTANT ASPECT OF TOPDRESSING IS THAT IT CHANGES THE PHYSICAL NATURE OF THE THATCH LAYER."

"The thatch layer is a very porous area," says Murphy. "By adding topdressing and making sure it gets beyond the blades of grass, you're getting soil in contact with whatever roots may be growing in this area, and getting nutrients to them."

Tips On Technique

Topdressing has its own set of application considerations including material selection, application rate and frequency, and "working in the material." While these will vary widely from situation to situ-

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Topdressers

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ation, there are some constants within these fundamental aspects of the practice.

Material Selection. Before you begin topdressing, you have to determine what you're going to topdress with. These materials can range from pure, USGA-specification sand, to soil, to organic material, to various combinations of these and more. Costs vary from material to material, from region to region. The choice, says Murphy, depends on the type of problem you're trying to address.

"But unless you're trying to physically change your soil, I am a firm believer in maintaining a consistent soil profile—matching your topdressing to the soil below it," he asserts.

"Get in touch with your local agronomist or extension agent," suggests George Kinkead of Turfco, Inc. "They're usually very willing to come out to your field and they can talk to you about what kind of material to put down. Remember that a topdresser is just one part of the process. The material itself has a cost, and that has to be factored in to the whole equation."

Application Rate And Frequency. These two elements of topdressing are so closely connected that it's next to impossible to mention one without discussing the other. Just like in mowing, where the general rule of thumb is never to remove more than one-third of the grass blade per cutting, you never want to "go overboard" in a single topdressing application. While opinions on topdressing rates vary, the rule of a maximum of 1/4 inch of material per application seems the most generally accepted.

"Dumping, for example, one inch of material at one time on the turf is worse for it than not topdressing at all," Bannerman asserts.

Murphy agrees. Instead, he says, frequent applications with less material are ideal.

"Try to put down topdressing as frequently as you can, so you don't develop layers and stratification," he suggests. "You don't want to *bury* a thatch layer. That would inhibit the flow of air and water through the soil profile by creating an interface. Topdressing applications that create layering can also affect the rooting of the turf.

"The rate at which you apply material should match the rate of development of thatch in the turf," he continues. "If you're fertilizing and watering a lot—practices that, however necessary, can promote thatch—then you probably should be topdressing frequently. Topdressing frequency is very much controlled by your other turf management practices. It's also affected quite a bit by the type of grass you're maintaining. Creeping bentgrass, for example, tends to form thatch faster than annual bluegrass."

Working In Or Grooming. If topdressing merely sits atop the turf and never makes it to the soil below, the application may be an exercise in futility. Yet topdressing will seldom "get down" on its own—it needs to be worked in or "groomed." This is particularly crucial in a sports turf situation, where the turf tends to be taller—hence farther away from the soil surface (increasing the distance that the topdressing must travel). To help the material make its way down, topdresser manufacturers have introduced brushes and tilling instruments.

"You definitely need some kind of spreading or grooming device to move the topdressing the through the turf," says Murphy. "Everyone seems to have a different way of doing it, but it's especially important if you're applying reasonably

heavy rates of topdressing. You have to work it in—irrigation alone won't do it.

"Some people aerify, then topdress, so that the topdressing can fall into the aeration holes," he adds. "Those who do, swear by it, although there are arguments on both sides and no definitive research that I know of has been done on the subject."

Topdresser Selection: Arm Yourself With Questions

There is enough topdresser product information, readily available through manufacturers, to fill the next few issues of this magazine—from shredding, material conveyance, and application rate control, to the rotational direction of brushes, hopper capacity, screens, ease of loading, and turf compaction characteristics and solutions. Naturally, manufacturers don't concur on all design and construction points. What they do agree on, however, is that as a buyer, you must ask many questions before making a decision.

Perhaps the first of these is: What size of an area to I have to cover? A topdresser targeted for golf greens is going to be a lot different than one designed for sports fields.

"All machines are not created equal," says Kinkead. "Most have their place, but not in all applications."

Typically, topdressers are not self-propelled. They're towed or mounted. You need to know what type and size of machine—tractor or utility vehicle—is required to use the topdresser you're considering.

That's just the beginning, says Kinkead. "As with any piece of equipment, sooner or later you'll need parts," he explains. "You need to know what are the most common parts that will wear out, how quickly you can get them, and how much they will cost. That means knowing not only *who* is supporting the product, but what kind of warranty support it has."

Kinkead adds that product demonstrations, with the type of topdressing material you'll be using, moist or dry, are a must. "You don't want a system that can't handle moist material," he notes. "That's why you should have product demonstrations done with the material you use, as opposed to material supplied by the manufacturer.

"Basically, there are four delivery systems for a topdresser or spreader. First, there's the hand and shovel—the oldest method in the book. Two, you have spinning spreaders, like those from Vicon, which are used mostly to apply fertilizer. And then you have the drop spreaders, which pour out material by gravity. Fourth, are those with the metered belt-to-brush design, which are generally considered to have the highest application accuracy."

Manufacturers should be able to provide you with names of people in your area who are using their products. While it's not terribly likely that a manufacturer would give you the name of an unhappy, dissatisfied customer, even satisfied end-users tend to be candid when discussing products.

"You wouldn't hire a person without checking references," Kinkead concludes. "You should approach topdressers, and all equipment purchases, in the same way." ❑

Topdresser Product Manufacturers

Bannerman
Rexdale, Ontario, Canada
(416) 247-7875

Cushman
Lincoln, NE
(800) 228-4444

Dakota Blenders
Grand Forks, ND
(701) 746-4300

Millcreek Manufacturing Co.
Bird-in-Hand, PA
(717) 656-3050

Partac Peat Corp.
Great Meadows, NJ
(800) 247-BEAM

Terracare Products Co., Inc.
Pardeeville, WI
(608) 429-3402

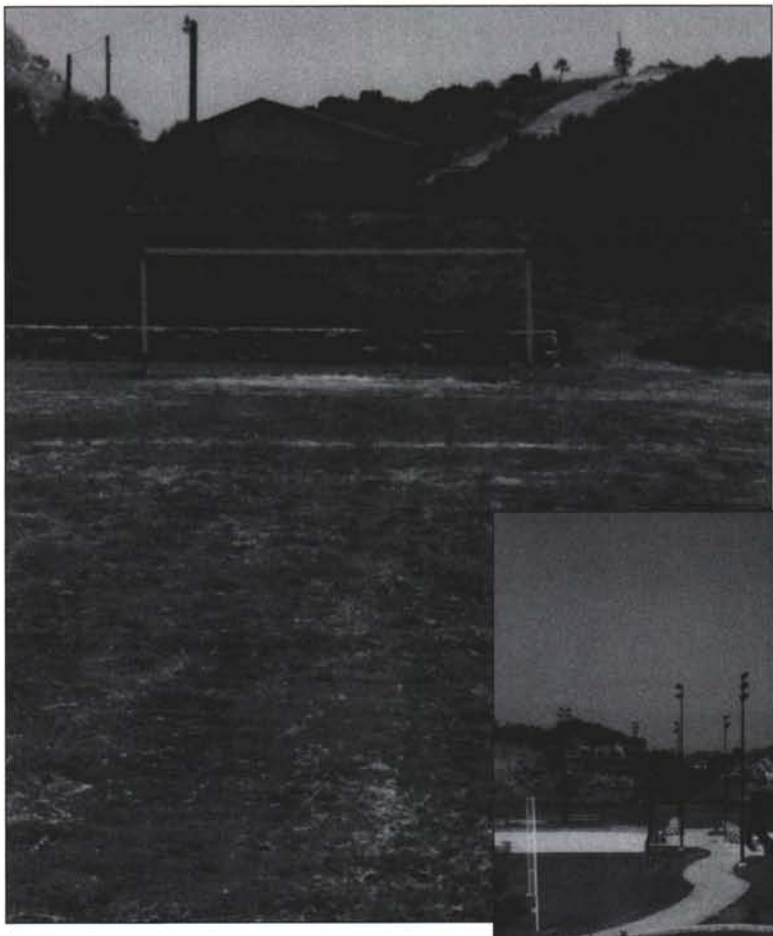
Turfco Mfg.
Minneapolis, MN
(612) 785-1000

Ty-Crop Turf Equipment
Chilliwack, B.C., Canada
(800) 845-7249

Voss Products
Milwaukee, WI
(414) 357-8377

Turf Renovation At Las Positas And The Alisal: *"Agroscopic Surgery"*

By Scott Buley



Right: Las Positas Park fields eight weeks after renovation. Dry spots were caused by an existing-and later corrected-irrigation problem. Above : One of the "better looking" portions of Las Positas Park prior to renovation. Photos courtesy: Scott and Nancy Buley.

The park had not been watered for several *years*. What once was a fine stand of tall fescue was reduced to clumpy bits of fescue, overrun by an ugly assortment of weeds.

With the resumption of normal rainfall after seven years of drought along California's Central Coast, the pressure is on turf managers to bring sports fields back to top quality as fast as possible. Of course, the water conservation lessons learned from those dry years must never be forgotten, and are a permanent addition to our arsenal of turf management practices.

The successful renovation and overseeding of fairways at The Alisal Golf Course in Solvang, CA, while I was superintendent, led turf managers at Las Positas Park to ask for renovation advice and assistance. The Santa Barbara, CA, park includes three baseball diamonds and two soccer fields.

The park had not been watered for several *years*. What once was a fine stand of tall fescue was reduced to clumpy bits of fescue, overrun by an ugly assortment of weeds dominated by burr clover. The poor soils underlying the site, built on a landfill, capped with 12 inches of clay mixed with chunks of asphalt and other burried objects, forced us to scramble to find appropriate renovation equipment.

There was an added challenge beyond technique and equipment selection—the fields needed to be ready for play as soon as possible. The fields were "officially" closed during renovation, but because the park area remained open the fields did receive some play during the process. While most turf managers want to cre-

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Mean Turfgrass Quality Ratings of Tall Fescue Cultivars At Four Shade Locations in the United States

Quality Ratings 1-9 9=Ideal Turf

Name	Mean
Arid	6.0
Finelawn I	5.6
Trident	5.4
Pacer	5.3
Mustang	5.3
Apache	5.2
Tempo	5.1
KY-31	5.0
Falcon	5.0
Houndog	5.0
Adventure	4.9
Jaguar	4.9
Bonanza	4.8
Olympic	4.8
Maverick	4.7
Willamette	4.6
Rebel	4.5
Clemfine	4.4
Brookston	4.4
Johnstone	4.0
Kenhy	3.4

Data from USDA National Turfgrass Evaluation Program

Drought Tolerance (Dormancy) Ratings of Tall Fescue Cultivars

Dormancy Ratings 1-9 9=No Dormancy

Name	Mean	Name	Mean
Arid	7.7	Chesapeake	5.7
Olympic	7.7	Tempo	5.3
Apache	7.3	Houndog	5.0
Jaguar	7.3	Pacer	5.0
Finelawn I	6.3	Johnstone	5.0
Mustang	6.3	Kenhy	5.0
Rebel	6.3	Maverick	5.0
Bonanza	6.0	Brookston	4.3
KY-31	6.0	Clemfine	4.3
Adventure	5.7	Trident	3.7
Falcon	5.7	Willamette	3.3
Finelawn 5GL	5.7		

Data from USDA National Turfgrass Evaluation Program

Brown Patch Ratings of Tall Fescue Cultivars

Brown Patch Ratings 1-9 9=No Disease

Name	Mean
Arid	6.3
Adventure	6.2
Jaguar	6.1
Rebel	6.0
Pacer	5.9
Maverick	5.8
Falcon	5.8
Clemfine	5.7
Apache	5.6
Tempo	5.6
Olympic	5.6
Houndog	5.6
Chesapeake	5.5
Finelawn 5GL	5.5
KY-31	5.5
Mustang	5.5
Bonanza	5.5
Trident	5.5
Johnstone	5.5
Finelawn I	5.3
Kenhy	5.0
Willamette	4.9
Brookston	4.3

Data from USDA National Turfgrass Evaluation Program

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Turf Renovation

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ate the best possible field conditions as quickly as possible, many must also minimize disturbance to the existing surface while maintaining play. Such was the case at Las Positas.

Choosing Renovation Tools

To radically change and improve the sports fields, while maintaining adequate playing conditions, we borrowed from lessons we learned during renovation at The Alisal. The 18-hole private resort course is open for play every day of the year, except for the occasional half-day closing of nine holes for routine aeration and sanding.

Much like arthroscopic knee surgery in sports medicine, which utilizes advanced diagnostic and laser techniques in medicine to minimize trauma, pain, and scarring to the athlete, the Toro Hydroject 3000, the Verti-Drain, and the the SISIS Airdrain are what I call "agroscopic" in nature. They cause a minimum of surface disturbance and scarring while maximizing "subterranean" soil improvement. And, like in medicine, the less you disturb the turf "patient," the sooner it will be up and running.

Conventional deep aerifiers would have brought up rock or broken many tines, so we opted for the SISIS Airdrain, which we'd first seen during a week-long Sports Turf Research Institute course in England. It proved very effective in slicing the ground deep enough to leach out the accumulated salts. Using this machine first allowed enough water to penetrate the heavy clay soil so the core aerator could work effectively. The Airdrain blades are designed like old-style broad swords, arranged in a high-tech spiral patter, and the machine works quickly. Deep slicing and verti-cutting broke up the mat of weeds, thatchy grass, and debris. Tons of material were vacummed off with Lawn Genies and a Giant Vac Sweeper.

Another bit of British technology we employed at Las Positas was 7/8-inch jumbo thatching tines for overseeding preparation. We had previously used them on the fairway renovation at The Alisal, attached to a Varicore three-point-hitch cam-driven aerifier. The combination created perfect, protected seed pockets, one-quarter to one-half-inch below the surface, which was ideal for growing seeded bermudagrass. For both renovation projects, we selected NuMex Sahara bermudagrass for its superior drought-tolerance under heavy-wear conditions. In our experience, conventional seeder-slicers hadn't been successful for overseeding bermudagrass because they weren't calibrated for such fine seed, the spacings were too far apart, and this type of grass didn't survive in a competitive situation with existing ryegrass and kikuyugrass stands in fairways.

At The Alisal, the 7/8-inch-diameter, one-half-inch-deep pocket on two-by-two-inch spacings assured the seedling survival and a competitive edge. In our experience, traditional seeder-slicing in the summer heat made it difficult to maintain adequate moisture at the seedling's shallow rooting depth. By creating a seed pocket with the thatching tine, we created millions of tiny seedbeds where the bermudagrass could grow without competition from existing grasses or compaction. We then reel mowed the plugs to partly refill the holes with loose soil and very little grass or thatch.

In previous renovation efforts, it had been nearly impossible to maintain adequate moisture for seedling survival without creating conditions too wet to continue play. Superintendents face this hydrophyllic-hydrophobic dilemma on their putting greens on a daily basis. With the protected seed pocket, we were able to continue using golf carts at The Alisal— and let limited play continue at Las Positas Park—in adequately moist ground with minimal seedling mortality due to compaction or wear.

It was interesting to note that, on the golf course, where water coverage was poor, the grass survived and thrived far longer in the protected seed pockets. This was particularly true of the NuMex Sahara bermudagrass on the fairways and tees, and the SR 1020 creeping bentgrass on greens.

More Trans-Atlantic Technology

Thanks again to our visit to England, we adapted a British-made Contraseeder, designed and calibrated for fines fescues and Colonial bentgrass, for use with NuMex bermudagrass seed and other bentgrasses. Using this machine and the ultra-lightweight walking Autoseeder, in conjunction with the shallow jumbo aeration tine, we were able to nurture an excellent stand on the Las Positas site in approximately two

months. Another seeding method that works very well—and we've found to be faster than slit seeding—is the use of a spiker-seeder on ground that has been prepared with shallow tine aeration

We reached the best results on The Alisal putting greens by aerifying, sand topdressing, and autoseeding in multiple directions at a rate of less than one-half pound per 1,000 square feet, and spike seeding a final pass to minimize visual striping. The Autoseeder's blades are particularly close to the hopper, which made application especially accurate and enabled us to reduce the seeding rate.

This method, coupled with deep drilling to 12 inches with a Powadrill, has substantially reduced the amount of Poa annua on the greens at The Alisal. It has also led to a healthy stand of SR 1020 bentgrass on the 40-year-old native soil greens that were in need of rebuilding because of severe black layer problems.

Our hope is that these and other "Old World" renovation techniques, which we adapted for use here at home, will improve the health, playability, and safety of turfgrass. All the techniques mentioned in this article apply to cool-season grasses. We use nearly identical techniques for fall overseeding of ryegrass into existing bermudagrass stands. Bermudagrass planted in August was successfully spike-seeded with ryegrass in late October without damaging the tender warm season turf.

On sports fields and golf courses, our goal is to keep turf surfaces in optimum condition year-round, even during periods of renovation and conversion to the "grass of the season." That's one of the true challenges of working in the transition zone.

On sports fields and golf courses, our goal is to keep turf surfaces in optimum condition year-round, even during periods of renovation and conversion to the "grass of the season." That's one of the true challenges of working in the transition zone. This can be done through innovative "agroscopic" turf management techniques, where the "surgery" is so sophisticated that the patient is up and running in no time. ❑

Editor's note: Scott Buley has served as a turf management and renovation consultant throughout the West Coast. He wishes to thank Marty Jenkins, executive director of the Las Positas Park Foundation, and Jeff Cope, assistant director of the City of Santa Barbara's Parks Department, for their cooperation during the renovation project.

Above: Dollar spot trial on bentgrass turf at the University of Illinois. Photos courtesy: Randy Kane.
Below: Heavy dollar spot in bentgrass fairway.

Development Of Fungicide Resistance On Intensively Managed Turf

By R.T. Kane And H.T. Wilkinson,
Chicago District Golf Association And University Of Illinois

Golf course greens, tees, fairways are undoubtedly the most intensively managed turf areas in the U.S., although some sports fields are approaching this level of management. Disease control on these intensively managed turf areas is achieved primarily through application of fungicides. In fact, statistics show that golf greens receive the greatest fungicide input per surface area of any U.S. crop, and the dollar value of the turf fungicide market is greater than for any other U.S. crop. Because of this intensive use pattern, fungicide resistance problems often show up on golf turf prior to any other crop application.

Fungicide resistance on golf turf is a fairly hot topic right now, primarily because of recent reports of dollar spot control failures with the newer systemic fungicides. However, fungicide resistance is not a new problem. Benzimidazole fungicides were introduced in the late 1960s; these products were the first widely used systemic fungicides, which displayed excellent long term preventative activity on a number of diseases. Disease control was so good with this revolutionary new chemistry that widespread, repeated, and intensive use of benzimidazole derivatives insued.

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Fungicide Resistance

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Subsequent reports of dollar spot ("Sclerotinia") control failures with benomyl surfaced by 1973-74, about four years after registration.

The purpose of this article is to bring everyone up to date on current systematic fungicide use patterns and modes of action, fungicide resistance problems we have observed in Illinois and around the Midwest, and current thinking regarding ways to best avoid development of a fungicide resistance problem on your intensively managed turf.

Benzimidazoles

This class of systematic fungicides includes benomyl (e.g. Tersan 1991) and the thiophanates (Cleary 3336, Fungo 50). When first introduced, benzimidazoles were widely used to control dollar spot and brown patch. The mode of action of these products is at a specific biochemical site ("single-site inhibitor"), which means that only a single gene alteration or mutation by a fungal pathogen could produce reduced sensitivity, or in some cases, near immunity to the fungicide. Dollar spot control failures are the most common resistance problem with benzimidazoles, but we also have observed loss of control of anthracnose (*Colletotrichum graminicola*) on *Poa annua* and creeping bentgrass. Lab tests show that the sensitivity to benzimidazoles of the resistant *C. graminicola* isolates is 100-fold less than "wild-type" isolates obtained from golf courses where no control problems have occurred.

Reduced sensitivity to benzimidazoles also has been reported by other turf scientists for *Microdochium nivale* (pink snow mold) and *Laetisaria fusiformis* (red thread). Also, in 1991 we identified a benzimidazole-resistant type of dollar spot on a Chicago area golf course where use of these products was suspended in the late 1970s because of disease control failures. Even after more than 10 years without exposure, the fungi still maintained their benzimidazole-resistant traits—i.e. this type of resistance is very stable. It is also interesting to note that there (apparently) have been no reports of *Rhizoctonia* brown patch resistance to benzimidazoles. Perhaps the benzimidazole fungicides have multiple sites of action against *Rhizoctonia* fungi, thus making genetic changes toward fungicide resistance more difficult.

Phenylamides

This special class of fungicides is targeted at Phycomycote fungi including *Pythium* and *Phytophthera* species, and includes metalaxyl (Subdue, Apron). Metalaxyl was introduced to the turf market in the late 1970s as the first systemic fungicide to control Pythium blight, and has been widely used since. The first report of disease control failure due to fungicide resistance was in 1984. We have documented one case of metalaxyl resistance in Illinois, in 1988. Laboratory tests again showed a near 100-fold decrease in sensitivity of *Pythium aphanidormatum* taken from the failure site as compared to wild-type isolates.

In the last two years, we have had our first reports of control failures with DMI on turf in the U.S.

Like benomyl, metalaxyl is a single-site inhibitor that can be overcome by a single gene change in a developing *Pythium* population. In some cases, it is believed that the population shift toward insensitivity is not due to a newly occurring mutation, but to selection over time of an already existing resistant genotype that was present in a very low percentage of the population.

Keep in mind that we have seen only one true case of metalaxyl resistance in Illinois over the 10 or so years of the product's use. Most disease control "failures" with this product can be attributed to one of the following: application rates are too low for a certain disease pressure; application is made too late (metalaxyl works best on a preventative basis with a 48-hour lead time); or, interval time between applications is too long.

On a related note, there are two fairly new systemic fungicides for control of Pythium blight—propamocarb hydrochloride (Banol) and fosetyl-aluminum (Aliette). So far, we have seen no reports of fungicide resistance or loss of field control with these products, although Sanders and coworkers at Penn State have induced resistance to fosetyl-Al in the laboratory. The models of action of both may be such that field resistance is unlikely.

Demethylation Inhibitors (DMIs)

This broad class of fungicides include the triazole derivative systemic fungicides, such as triadimefon (Bayleton), propiconazole (Banner), and myclobutanil (Systhane or Eagle). Also included are pyrimidine-methanol derivatives such as fenarimol (Rubigan). The site of action in sensitive fungi is the biochemical pathway for synthesis of a fungal sterol called ergosterol, so you may see this class of fungicides referred to as sterol biosynthesis inhibitors (SBIs) or ergosterol biosynthesis inhibitors (EBIs). It is now known that toxicity to fungi stems from inhibiting demethylation of ergosterol precursors, thus the name "demethylation inhibitors."

DMI fungicides are considered to have a single-site (or perhaps two-site) mode of action. This would seem to put these products at the same risk level for resistance development as benzimidazoles or phenylamides. However, until recently there were very few reports of field resistance to DMIs. Reports of reduced effectiveness of DMIs have appeared on a number of agricultural and fruit crops—primarily from Europe where DMI use is more intensive.

In the last two years, we have had our first reports of control failures with DMI on turf in the U.S. The culprit again is dollar spot. In the Chicago area, we have documented one golf course site where DMI products have gradually lost there effectiveness in controlling dollar spot. The level of control on affected fairways is now totally unacceptable. Laboratory tests of dollar spot isolates from this site indicate that the decrease in fungicide sensitivity is fairly low (10-fold), i.e. the fungi have become "tolerant" of the fungicide, not totally resistant as with benzimidazoles. We may see development of more of a problem with DMIs over the next few years, if use patterns don't change (more about this later).

Another important aspect of DMI use on golf courses is application of growth retardants such as paclobutrazol (TGR) and flurprimidol (Cutless). Paclobutrazol is a triazole compound similar to the triazole fungicides, and flurprimidol is a pyrimidine-methanol derivative similar to fenarimol. The mode of action of these growth retardants is also very similar to the fungicides; they are sterol biosynthesis inhibitors. Plant growth rates are reduced by inhibiting syntheses of the hormone gibberellin, a type of sterol molecule found in plants. Repeated use of DMI fungicides and growth retardants on fine turf can have several consequences. One is possible adverse effects on health of desirable grass species from an overdose of DMIs. Phytotoxicity, increased or prolonged growth suppression, increased coarseness or steminess, and increased susceptibility to certain diseases have all been observed.

Dicarboximides

This class of fungicides includes the turf fungicide iprodione (Chipco 26019)