〈특별기고〉

Environmentally Sound Turfgrass Management

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미국 골프코스의 친환경적 잔디관리

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Introduction

Environmental issues have been a serious concern to the turfgrass industry since the late 1980's. The industry is under increasing pressure to decrease the amount of pesticides used in turfgrass management. In some areas, bans on the use of pesticide have been proposed. While it may be possible to reduce pesticides on intensely managed turf areas like golf courses and sports fields, trying to manage these areas without the use pesticides would be difficult, and may be impossible in high stress environments.

Many of the pest problems that occur in turf are related directly to the management system used on the area. This is particularly true on the golf course where intense management regimes may lead to problems not found on lawns and other turf areas with less extreme management systems.

A good example of this is the weed *Poa annua* (annual bluegrass). *Poa annua* is a relatively weak grass that does not compete well with better adapted species under normal management systems. It is, however, very well adapted to low mowing heights. It is usually found on close mown turfgrass areas on greens, tees, and fairways, where the grass is maintained at very low mowing heights. *Poa annua* is also favored by heavy irrigation and fertilization. These again are management practices typically found on intensely managed golf courses(Fig. 1).

Poa annua, then, is a problem caused by the management system. It would be possible to all but eliminate this weed by simple raising the mowing height and by fertilizing and watering less. This

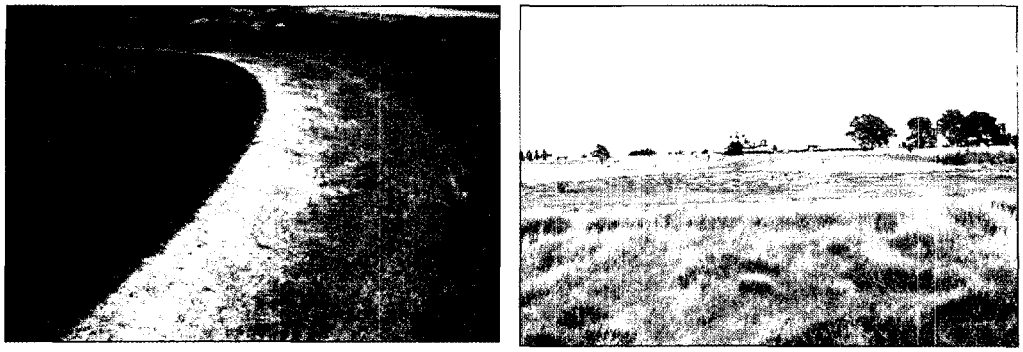

Fig. 1. Dead Poa annua on green color and abandoned golf course

would be an impractical solution on the golf course, however, because the game of golf requires low mowing heights and intense management. As a result, we generally end up managing *Poa annua* and living with the problems that it causes.

Turfgrass diseases are also generally related to stress caused by the management system. Diseases like brown patch, and Pythium blight may occasionally appear on higher mown grasses, but it is on the golf course where they cause the most problems(Fig. 2). Low mowing heights cause a great deal of stress to the grass. Add to this heavy nitrogen (N) fertilizer applications and excess irrigation, and diseases that are rarely a problem can cause serious turf loss. Again, most of these disease problems could be reduced by simply increasing the mowing height and reducing irrigation and fertilizer, but it would not be possible play the modern game of golf on turf managed in this way. The solution is to use fungicides to control diseases, but this may result in environmental issues over the use of these chemicals.

The need for pesticide and fertilizer in the maintenance of quality turf is also closely associated with the environment in the region where the turf is to be managed. In Scotland, where the game of golf began, the climate is such that grass can be maintained with a minimal input of pesticides. If these same golf courses were to be relocated to the central transition zone of the United States or to other high stress environments around the world, they

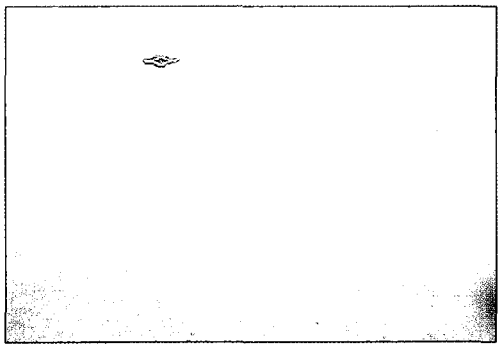

Fig. 2. Turfgrass diseases on golf course green

would quickly die without an intense management programs. Fungicides would be particularly important in keeping the grass alive in these high-stress areas.

Maintaining golf courses and sports fields in high-stress environments without the use of pesticides would be nearly impossible. But that doesn't mean that we should give up and use pesticides indiscriminately with no thought to environmental issues. Modern turfgrass management requires a 'common sense' approach that combines the proper use of pesticides with a thorough knowledge of how the grass interacts with its environment. This is difficult and requires well-trained turfgrass managers that can combine their knowledge of botany, horticulture, soil science, and irrigation technology to develop the best conditions for the grass. It also requires knowledge of how to most effectively use pesticides when they are needed. This is often referred to as "Integrated Pest Management" and represents the best type of modern turfgrass management systems.

Integrated Approaches for Disease Control

The first step in developing an effective disease program involves knowledge. The turfgrass manager must know as much about the conditions that favor grasses as possible. This must then be coordinated into an integrated management program designed to produce a healthy plant that will resist attacks by the many fungi that can kill grasses.

Mowing height

The lower the mowing height, the greater the stress on the turf. While mowing height is usually determined by the needs of the game on golf courses and sports fields, whenever possible, raising mowing heights will help reduce stress. This is particularly important for cool-season grasses during high stress periods. Slightly raising the mowing heights on greens, tees and fairways in midsummer can lower stress and help reduce the need for fungicides.

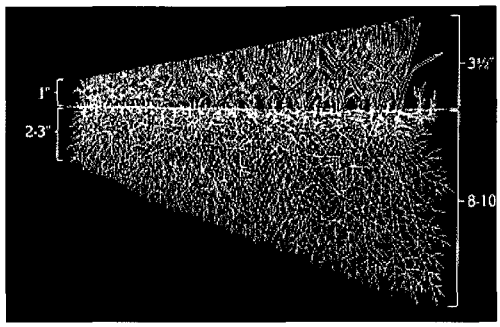

Fig. 3. Higher mowing heights favor root and rhizome growth

Fertilization

High N programs result in plants with high moisture content in their cells, thin cell walls and a thin cuticle on the plant's surface. Plants in this condition are more easily attacked by diseases like brown patch, Pythium blight, and snow

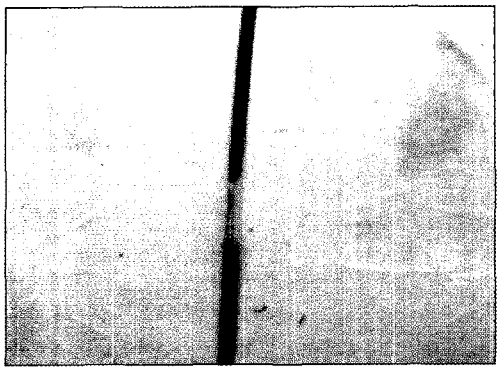

Fig. 4. Symptoms of dollar spot on bentgrass

mold. Plants that are deficient in N can also be more susceptible to diseases like dollar spot, red thread, and rust(Fig. 4). Part of the control strategy for these diseases is a boost in the N fertility rate. A balanced N fertility program that gives the plant enough N without over stimulating it,is an important part of an integrated program to reduce fungicide use on turf.

Other nutrients, such as phosphorus (P), potassium (K), iron (Fe), and magnesium (Mg) can also play a role in a disease control strategy. Turf that is deficient in these elements will be less capable of resisting attack by pathogens. A well- balanced fertility program based on a sound soil testing program plays an important role in developing a disease control strategy.

Irrigation

A well balanced irrigation regime is also a critical part of reducing stress. Both too much water and too little water increase stress on the grass that can increase its susceptibility to diseases. An excessively wet root zone restricts rooting and provides a good environment for fungi. Turf under low-moisture stress is also more susceptible to diseases such as summer patch. Carefully managing the irrigation system, then, is an important part of reducing fungicides.

pH

Balance is again important when it comes to soil pH. The best soil pH range for grasses is between 6 and 7. Low pH's favor fungi and put stress on the turf that makes it more susceptible to

Fig. 5. Thatch layer and core aerification

many diseases. Liming can raise soil pH and help reduce disease development in turf maintained on low-pH soils. High pH's can also place stress on the turf and high pH soil media should be avoided if possible. It is very difficult to lower the pH of most high pH soils.

Thatch

An excessive thatch layer can put stress on grass. Pythium blight is often a problem on turf with excessive thatch layers. This thick organic layer on the soil's surface can restrict rooting and provides a suitable environment for certain fungi to grow. Proper fertilization and irrigation is the best way to prevent the formation of a thatch layer. Core aerification is the best way to reduce a thatch layer once it has formed(Fig. 5).

Drainage

Poor drainage places excess stress on turf and improving drainage with sub-surface tile, or properly constructed surface drains can be an important part of an integrated disease control program(Fig. 6).

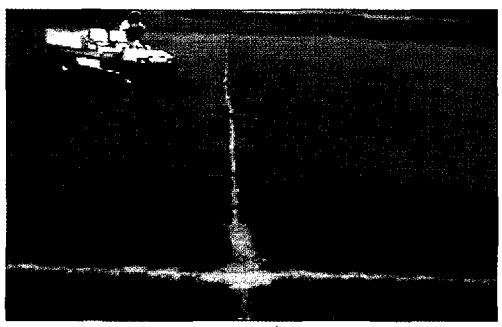

Fig. 6. Surface drains on fairway

Air movement

Poor air movement can have a major impact on disease development. The most destructive summer diseases, like Pythium blight, are often found in areas on the golf course with poor air movement. Trimming under plants and low hanging branches can improve the situation. Electric fans are also commonly used on golf greens maintained in high-stress environments.

Poling

Before the development of modern fungicides, long poles were used on greens to remove the dew in the morning and to facilitate drying of the surface. Poling is still an effective cultural practice to help reduce disease problems. A water hose, rope, or plastic chain can also be used for that purpose.

Syringing

Another process that can be used to reduce stress during high-temperature periods is to apply light applications of water to the turf's surface. Syringing can help cool the green's surface, but more importantly it washes sugars and other extruded materials from the leaf surface that provide a food source for the fungi. Syringing is used as part of an integrated disease control program to reduce Pythium blight infestation on creeping bentgrass greens in the

summer. It is also very important in the management of annual bluegrass during high-temperature stress periods.

Disease-resistant cultivars

Leaf spot is a common disease of Kentucky bluegrass. Some bluegrass cultivars are very susceptible to this disease, while others show resistance. Turf that are damaged by leaf spot each year could be treated with fungicides, but a more environmentally sound approach would be to replace the susceptible cultivars with resistant ones. This can greatly reduce the need for fungicide applications. There are few diseases for which this approach works, but where it is available, it is an important part of a reduced-fungicide program.

Use the right grass

Choose the grass species that are best suited to the environment in your region. Creeping bentgrass is not well adapted to high-stress environments in warm climatic regions. Bermudagrass is much better adapted to warm climates. Likewise, the use of a poorly adapted warm-season grass like bermudagrass in a cool-climate would be a mistake.

Record keeping

The final step in developing a sound disease management program for turf is to keep good records. Many diseases return to the same area year after year. Good records will allow for the targeting of problem sites and may reduce the amount of fungicides needed to manage the area. Summer patch, for instance, may return each year to the same location. It must be treated with fungicides before the onset of the disease and good records can improve the efficiency with which the chemicals are used.

Integrated Approaches for Weed Control

As with diseases, there are many management related techniques that can be used to prevent weeds and reduce the amount of herbicides needed to manage turf areas. The best weed control is a well maintained turf stand. Very few weeds can out-compete turf if it is properly managed. They are generally the same steps outlined above. A proper mowing height, combined with a well balance fertility program, and a sound irrigation regime that meets the needs of the turf will do a lot to prevent weeds and reduce pesticide use.

Environmentally Friendly Pesticides

The original pesticides developed in the early part of the last century were often deadly compounds that contained lead, mercury, cadmium and other heavy

metals that were dangerous for humans and very detrimental to the environment. These were replaced by safer, organic compounds in the 1970's, although some of these compounds still presented a serious risk to the user and could have detrimental environmental impacts.

The current trend in the development of new pesticides involves a return to nature. Herbicides, fungicides, and insecticides are being developed from naturally occurring compounds. Imidacloprid (Merit), which is based on nicotine, is one of these materials. It has proven to be a very useful material for the control of several white grub species in turf. Corn gluten meal, a natural material extracted from corn (Zea mays)grain, has also been shown to be an effective preemergence material for the control of annual weeds in turf(Fig. 7).

There are many naturally occurring bacteria and fungi that extrude chemicals that help keep the balance among these organisms in the ecosystem. These can be extracted from the soil, their chemical structures identified and new compounds based on their chemistry can be produced. These materials are often very specific to certain pest organisms and have little impact on humans. These products have a greater degree of environmental safety that older materials and can be a new, useful tool for those wishing to reduce environmental impacts of pesticides. Azoxystrobin (Heritage), a fungicide that was based on a naturally occurring compound extruded by a fungi found growing on pine cones is a good example.

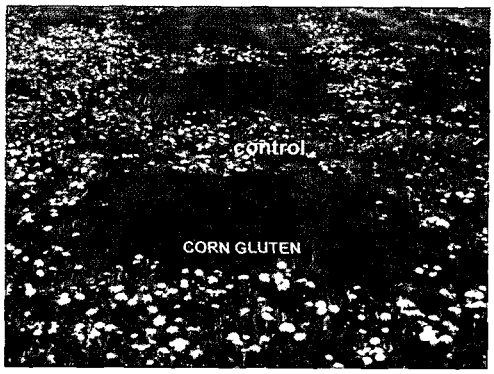

Fig. 7. Weed control experiments by natural products

These types of materials represent the future for the development of pesticides and should lead the way to many new materials that have a much higher degree of safety for the user and for the environment.