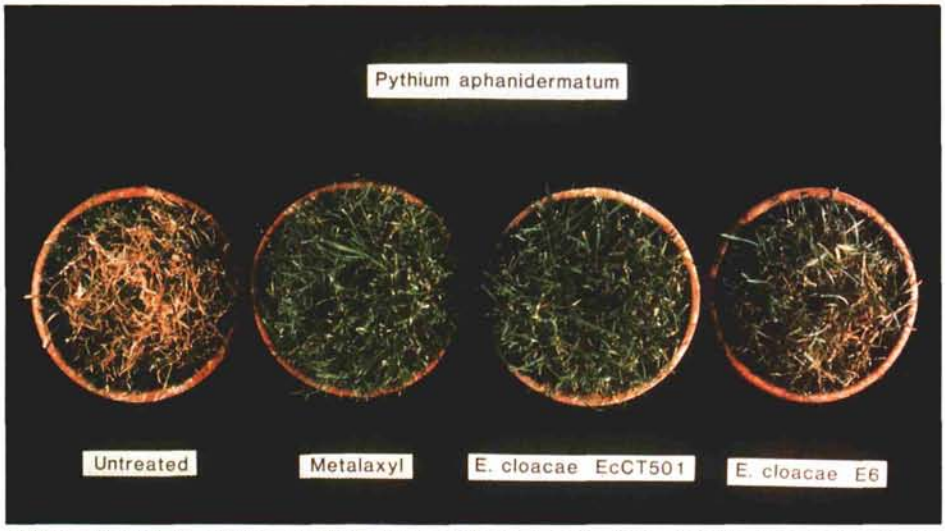

Effect of various strains of Enterobacter cloacae *and the fungicide metalaxyl on the suppression of* Pythium *blight of perennial ryegrass in growth chamber experiments. Disease severity was rated on a scale of 1 to 5, for which 1 equals no foliar blight and 5 equals 100 percent foliar blight. A — Nontreated; B — Drenched with metalaxyl (750 µg a.i./ml); C — Treated with* E. cloacae *strain EcCT-501; and D — Treated with* E. cloacae strain E6. (From Nelson & Craft, 1991).

behavior without an understanding of the microbial traits important in pathogen or disease suppression. It also follows that the performance of antagonists could be effectively enhanced if their function was clearly understood.

The traits necessary for an antagonist to suppress turfgrass disease are unknown; however, a number of traits are currently being investigated. For example, these traits include the ability of antagonists to produce fungicidal compounds or compounds that make nutrients unavailable to pathogens. Other traits include the ability of antagonists to parasitize pathogens, colonize plant parts, and compete with pathogens for resources in soil and on plants.

The use of topdressing materials amended with disease-suppressive composts or organic fertilizers has received some acceptance by turfgrass managers as an attractive disease-control alternative. Many composted materials and organic fertilizers are commercially available from distributors or municipal waste treatment facilities. Preliminary research has shown that use of composts and organic fertilizers for turfgrass disease control is economically and technologically practical and, in some instances, can provide reasonable levels of disease control. In the few cases that have been examined with some of these materials, a reduction in fungicide use has accompanied the adoption of this biological control strategy.

Before disease-suppressive composts become widely accepted and used for disease control, the principal problem of a compost not being consistently suppressive from year to year, batch to batch, or from one site to the next must be solved. Turfgrass managers and compost producers agree that the future success of these materials in commercial turfgrass management depends upon the ability of producers to provide materials with predictable levels of disease control. Gross variation in disease-suppressive qualities of composts cannot be tolerated because end-users need to be assured that every batch of compost used specifically for disease control will work every time.

Unfortunately, we do not yet know how to predict the suppressive activity of certain composts without actually testing them in field situations. A number of tests have been developed to determine compost maturity and degree of stabilization for the purpose of reducing the variability in physical and chemical properties. Very little of the research, however, has been designed to directly assess microbiological aspects of maturity and disease suppressiveness. Currently, predictive tests based on levels of microbial activity and organic matter quality are being explored through this research project as potential tools for predicting composts' disease-suppressive properties.

Back to the Basics for Golf and the Environment

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LOOKING ahead into this decade of environmental concerns, it is a distinct possibility that superintendents throughout the country will experience restrictions in the application or availability of pesticides. To prepare for these future reductions, there is a need to search for alternatives to make grasses healthier and less chemically dependent. The successful superintendent in the 1990s will be one who is able to combine proven agronomic practices of the past with some of today's technology. A "back to basics" approach will help you meet the environmental challenges at your doorstep.

Three of the most important factors in maintaining healthy turf are proper nutrition, reasonable cutting heights, and regular aeration. In order to prepare a fertilization program, the soil from a portion of the greens, tees, and fairways should be tested annually. For best results, it is preferable to continue with the same testing laboratory to achieve a consistent evaluation year after year.

When test results are received, they should be examined closely and compared to the previous year's analysis. Adjustments can then be made to provide optimum growing conditions for the turf. In particular, potassium and phosphorous levels should be closely monitored. Soil potassium can be depleted due to rapid uptake by the turf as well as its tendency to be leached through the soil profile. This results in

reduced vigor and turf that is less tolerant of stresses of all types (traffic, cold, heat, pests, etc.).

To counteract this nutrient depletion and improve turf performance, many superintendents have opted to apply potassium at a ratio of 1:1 with nitrogen to their greens. Potassium applications should be split among several different sources. Because of its low salt index and its acidifying effects, potassium sulfate has become the standard for turf. However, research is proving that other potassium sources also have multiple benefits to turfgrass. Potassium chloride is thought to be a good preventative for diseases such as take-all patch. With the incidence of this disease increasing at courses throughout the country, including potassium chloride in your fertilizer program could be a prudent move. Watch out for the burn potential of this material, though.

Potassium nitrate has its advantages as well. A low salt index makes this an excellent potassium source. Additionally, research at Michigan State University indicates that nitrate-based fertilizers can be of particular importance for golf courses which have experienced black layer problems. Their research suggests that nitrates limit the accumulation of sulfides, which contribute to the formation of black layer. Granted, good drainage and proper irrigation are the main keys for inhibiting black layer formation, but potassium nitrate is another weapon you can put in your arsenal when combatting this frequently seen condition. Finally, when seed of some varieties of grass (such as buffalograss) is treated with potassium nitrate prior to planting, a significant increase in germination can be expected.

While increasing use of potassium has met with a positive response in recent years, the opposite has occurred with phosphorous. To many superintendents, the mere mention of the word phosphorous conjures up visions of *Poa annua*. But that should not be the only consideration. With the advent of frequent, light topdressings, an additional inch of sand and organic matter can be added to the soil profile every couple of years. Most sands used for this purpose are practically sterile and contain very little phosphorous. With these thoughts in mind, it is easy to see that in a very short time the upper few inches of the profile could become phosphorous deficient. In these cases, light, foliar applications of phosphorous can sometimes produce a favorable turf response, even though soil tests may indicate adequate phosphorous levels. Generally, three to four applications of monoammonium phosphate (14-61-0) at the rate of .25 pounds of P_2O_5 per thousand square feet will benefit the turf both above and below the surface. For a more accurate analysis of available rootzone phosphorous, as well as other nutrients, a separate sample composed of the upper one to two inches of the profile should be submitted.

Mowing Height

Another critical factor in getting back to the basics is mowing height. There is no doubt that turf stress increases as the cutting height is lowered. This is particularly true on greens where the cutting height has reached $\frac{1}{8}$ inch or less. Putting surfaces often become thin, algae infested, and more prone to failure. While the grass may tolerate low heights for short periods of time, a wise superintendent will keep his resume updated when attempting to maintain these extremes on a daily basis. Instead, a return to mowing heights of $\frac{5}{32}$ or $\frac{3}{16}$ inch is recommended to sustain healthy turf. Speed can be preserved by more frequent grooming, light topdressing, and other techniques.

Although contested by many golfers, the benefits of aerification to the turf are undisputable.

Tim Uptmore, golf course superintendent at Cottonwood Creek G. C., in Waco, Texas, recognizes that soil profiles should be taken on a routine basis to determine topdressing frequency.

Grooming can be done as often as every other day when the turf is healthy and the weather cooperative. Light topdressing is sometimes done once a week during the same period. This may seem like too much sand, but instead of using a spreader attached to a truckster, some superintendents utilize a walk-behind rotary-type fertilizer spreader or similar unit. About one hopper-full of sand is applied every week to each green. Now, that's not much sand!

The best way to determine the rate and frequency of topdressing is to utilize a soil profile tool. Though many of these are seen in superintendents' offices, most collect more dust than soil. Remember, the rootzone is constantly changing as the plant contributes organic matter and as topdressing accumulates. By taking a profile on a regular basis, the developing rootzone can be monitored to ensure layering does not occur. Unless this is checked routinely, the topdressing schedule is merely a guess.

Aerification

The third factor mentioned earlier is aerification. Arguably, there is no other single cultural practice that produces stronger, healthier turf. The alleviation of compaction, improved drainage, and increased gas exchange associated with aerification promotes deeper rooting. As a rule, the deeper and more often the greens are aerified, the more consistently healthy the turf will be. In days past, greenkeepers bought out a hardware store's supply of pitchforks in order to break through compacted layers to promote air and water movement deep into the soil profile. Fortunately, today we have excellent mechanized equipment to accomplish this task. The success of these machines and the rapid growth of this market are tributes to well-founded agronomic principles adopted by turf managers many years ago.

Another "secret" of turf managers in the past was to spread a gallon of water mixed with pyrethrum or liquid detergent over a one-square-yard area of turf. Within a few minutes irritated insects would come to the surface of the green, and correct identification could be made. This procedure still works well today, especially for armyworm, cutworm, and sod webworm detection. Simple techniques such as this allow early detection of insect pests and can be a helpful tool as golf course superintendents develop effective IPM programs. Finally, circumstances which lead to devastating losses of turf can occur when disease organisms are misdiagnosed and subsequently sprayed with the wrong fungicide. As it stands now, a superintendent has the option of spraying one product after another until the effective material is pinpointed. This option may not be available to superintendents in the near future. To ensure proper identification, the following steps should be taken.

- Consider the environmental effects under which the disease has prospered, such as temperature, humidity, light, etc.
- Be aware of the disease history on your particular course. In other words, be familiar with areas of the course that are most susceptible to certain diseases, and scout these areas frequently.
- Become knowledgeable of the injury symptoms, which include patterns (patches, spots, streaks) and visible signs (mycelium, wilt, etc.).
- Acquire a microscope and become familiar with its use. Though microscopes are not helpful with all diseases, they can give you an edge when the going gets tough.
- Make use of commercial detection kits for identifying or ruling out certain diseases.
- Cultivate a good relationship with your local or state extension turf pathologist.

There is no doubt that golf course superintendents and golfers will have to deal with many changes in the 1990s. Absolute perfection on the course is no longer a reasonable or practical goal, but this does not mean that we will have to sacrifice healthy turf and good playing conditions. As chemical tools are lost or restricted, turf managers will have to rely on solid agronomic principles and practices. This "getting back to basics" approach always has been extremely effective and always will be.