Management of Turfgrass Diseases

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(From the following OSU Extension bulletin)

Management of Turfgrass Pests, Weeds, Diseases, and Insects

Bulletin L-187

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Integrated Turfgrass Health Management

In the past, when a problem occurs in turfgrass — it turns brown, gets weeds, is infected by diseases or infested by insects, mites, and other animals — our primary approach was to try and eliminate the problem, not deal with the cause of the problem! Often we just applied the currently recommended herbicide (weed killer), fungicide, or insecticide. It soon became apparent that this approach didn't adequately deal with these pest problems. We also found that the pests occasionally became resistant to the constant use of pesticides and the pesticides themselves ended up in parts of the environment where they were not wanted! This gave rise to the use of the **Integrated Pest Management** (IPM) approach.

In using IPM, pests are monitored on a regular basis and one or more pest control tactics are used — cultural controls (e.g., using resistant turf, physical removal, water management, conservative use of fertilizers, etc.), biological controls (e.g., parasites, predators, diseases, and competitors), AND chemical controls (e.g., the pesticides). In essence, IPM is a decision-making concept. If I have a few dandelions in my yard, will hand digging eliminate them? Or, are the dandelions widespread and a broadleaf herbicide would be more efficient and effective? Once eliminated, why did the dandelions become established in the first place? Are there open places in the lawn or is the turf not very dense because of inadequate watering and fertilization? While applying the herbicide will certainly eliminate the dandelions (a short term solution), increasing the density of the turf will likely prohibit more dandelions from establishing (a long term solution).

While the IPM approach often includes doing "cultural" things that improve the hardiness and sustainability of the plants, the emphasis is still on pest management. However, PLANTS are the key part of our lawns, grounds, sport fields, and golf courses and we know that "healthy" plant systems generally resist invasion by weeds, are more resistant to disease attack, are better able to withstand insect attack, and such systems can better deal with extremes of weather conditions (i.e., drought, heat, and cold). The current thinking is embodied in the idea of **Plant Health Care** (PHC), or in our case **Integrated Turfgrass Health Management** (Figure 1).

Turf needs a basic foundation in which to grow, whether it be native soils or artificial "root zone mixes" used on golf course greens and top athletic fields. Each soil type influences how the grass plant roots pick up and utilize nutrients, water, and oxygen. Soils lacking in certain elements may need to be modified periodically to make them more suitable for the growing of turfgrasses. If this is not done, the grass plants are likely to thin out or die (allowing weed establishment), or stress the plants so that they are more susceptible to disease and insect attack.

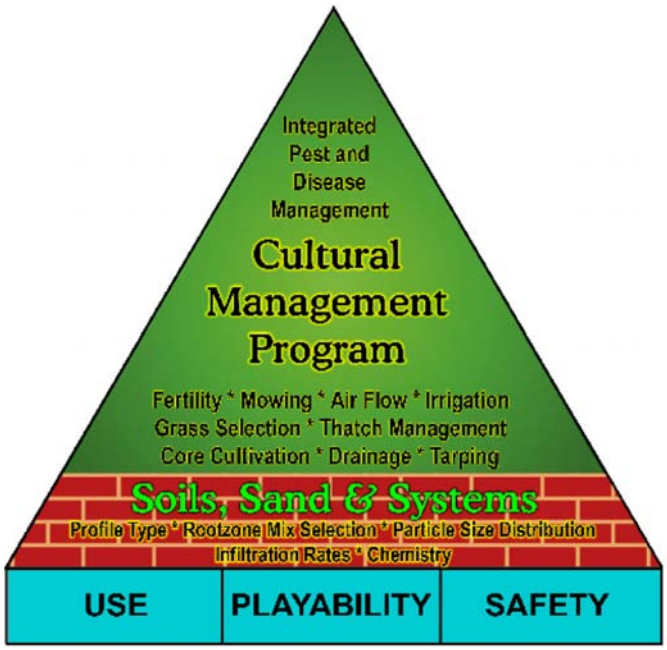

Figure 1. A model of key Integrated Turfgrass Health Management (ITHM) factors.

Above ground, turfgrasses are also regularly managed by mowing, irrigation, and applications of fertilizers. Thatch management, drainage, core cultivation, overseeding of grass species and/or cultivars, tarping, and modifying air flow are other cultural management techniques used to maintain turf health.

Even with the best of soil conditions and cultural management program, turfgrasses can be colonized by weeds or attacked by diseases and/or insect pests. When this occurs, we still use the IPM approach to manage these pests, BUT, we also look at our general turf management program to see if there is something lacking or could be done to improve the health of the turf so that it can better withstand pest attack.

Selecting the Right Turfgrasses

Each species of grass used for turf has its own unique characteristics though its characteristics can be dramatically changed through selection and breeding. Kentucky bluegrass is great at filling in open places, but it is relatively susceptible to disease and insect attack. Perennial ryegrasses are quick to establish, but their bunch-like growth habits make them poor at filling in voids. Perennial ryegrasses with endophytes are quite resistant to surface insect pests, but the same grasses may be susceptible to disease and/or white grub attack.

Turf-type tall fescues have very deep root systems that make them naturally resistant to drought and white grub attack and many have endophytes that resist surface insect attack. However, tall fescues often don't take much wear and their bunch-habit means that they won't fill in open areas without overseeding.

In most turfgrass situations, we recommend establishing a blend of a single species that is most suitable for its use, not a blend of species. Blends of "cultivars" improves the genetic diversity of the stand so that it is more likely capable of withstanding pest attack. Blends of grass species are useful in specific situations (e.g., sports fields), but such blends often "segregate" over time, yielding a lawn or turf cover that varies in color and texture.

Information regarding turfgrass cultivars and/or blends most suitable for your location may be obtained by contacting local seed distributors, extension specialists, and via the National Turfgrass Evaluation Program (NTEP; http://www.ntep.org). The NTEP site also has some listings of turf cultivar resistance to disease and insect attack. The use of genetically resistant turfgrass should be considered when establishing or renovating turfgrass areas or in situations where overseeding is used.

Turfgrass Establishment

Before establishing turf, you should have the soil evaluated. For most lawns, a simple soil test will likely work, but in more complicated turf usages (e.g., athletic fields or golf courses), soil type analysis (clay, silt, and loam content), infiltration rates (how fast rain or irrigation will work into the profile), and organic matter content are factors to be considered. Even with home lawns, adding organic matter (such as compost) to the top inches of the existing soil can aid in seed or sod establishment.

When taking a soil sample, be sure to take several samples across the area to be covered with turf, send to a reputable soil testing lab and mark that you want recommendations for turf establishment and maintenance.

Seeding and sodding are the two common methods of establishing stands of turf. Seeding is relatively simple and less expensive. Late summer seeding is usually more successful due to more regular fall rains. Early spring seedings will need irrigation to get the young plants through summer drought. Sod can be applied almost any time during the growing season as long as irrigation is available until a new root system has been established. Whether seeding or sodding, proper soil bed preparation is essential for turf health. Adding compost to existing soil, adding high quality top soil, and alleviating any compacted areas are important soil factors that encourage sustaining root systems.

General Maintenance

Regular mowing, fertilization, and irrigation are the most important maintenance tasks needed to maintain turfgrasses.

Except for the short cut needs found on golf courses, most turfgrasses should be mowed on a regular basis at a 2.5 to 3.0-inch height. Mowing turf should follow the "one-third rule," that is, no more than one-third of the grass height should be removed. In periods of rapid growth, turf may need to be mowed every three to four days in order to follow this rule. Normally, weekly mowings will fulfil the one-third rule quite nicely!

When mowing, return the clippings to the turf! Turf clippings contain valuable nutrients which are easily recycled in the turfgrass system. Removal of clippings will only add these nutrients to the land fill, and require more fertilizers to be applied in order to maintain turf health and quality.

Most lawn and athletic field turf needs no more than three pounds of nitrogen (the most essential element) per year. The other major nutrients, phosphorus and potassium, and minor nutrients should be applied according to recommendations obtained after periodic soil tests (every two to three years).

Most turfgrasses don't need irrigation unless you desire them to remain green during their normal summer dormancy period! Obviously, golf courses, sport fields, and commercial facilities require irrigation in order to maintain green cover, but home lawns will not suffer if allowed to go dormant during the heat and drought of a normal July and August. To keep turfgrasses green, they will normally need about 1/2-inch of water (rain and/or irrigation) per week or more during periods of excessive heat and sun.

Thatch Management and Core Cultivation

Thatch is the layer of dead and living organic matter that can accumulate on the soil surface. All turf will form thatch and this thatch is considered beneficial to the turf as long as it doesn't become excessively thick (over 1/2-inch). Some turf species (especially Kentucky bluegrass and bentgrass) are quite prone to developing excessive thatch layers on Ohio's clay soils, especially if they are over fertilized and irrigated.

Earthworms and microbes (beneficial fungi and bacteria) are the major agents involved with breaking down thatch. However, both need soil and water to perform this task. Core cultivation generally pulls plugs of underlying soil to the surface and this soil will filter down through the thatch, aiding in its decomposition. Core cultivation can also provide channels into compacted soil for roots to grow.

Occasionally, thatch gets completely out of control (3/4-inch thick or more). This excessive thatch build-up sometimes can be reduced by increasing core cultivation to two to three times a season. If this doesn't work, more radical treatments may be needed — de-thatching or replacement. De-thatching equipment will pull out the thatch so that it can be raked up and disposed of in a land fill or composted. Whenever this needs to be done, you should carefully review your general maintenance program to determine what modifications in fertilizer rates, irrigation, and mowing should be done.

Complexity of Turfgrass Systems

There are several unique characteristics of turfgrass systems that must be considered before an effective disease management program can be developed.

First, turfgrass is a perennial crop whose "yield" is measured in terms of how well it withstands use (i.e., playability of athletic fields or golf course putting greens), how good it looks (aesthetic qualities), and its environmental impact (erosion control, noise buffer, heat dissipation, enhancement of surface water quality, etc.) rather than in bushels per acre.

Second, most turfgrass swards represent mixed stands of multiple species, cultivars, or both. The situation is even more complex because most turfgrass species are comprised of synthetic cultivars made up of co-populations of genetically diverse individuals that often segregate over time. Older creeping bentgrass putting greens typically show this type of segregation.

Third, turfgrass is used in many different ways such as on athletic fields, golf courses, home lawns, roadside ground covers, and grassy waterways, each requiring a unique management program. In other words, one management program will not fit all turfgrass systems. Golf courses are inherently complex because different turfgrass species/cultivars and maintenance practices are used for different functional areas (i.e., putting greens, fairways, roughs, tees, and club house surroundings).

Lastly, high-value turfgrass systems, such as golf course putting greens and professional athletic fields, are intensively managed (i.e., daily mowing, irrigation, core aerification, topdressing applications, painting, etc.). Although frequent manipulation allows for timely intervention of problems, it can also lead to increased wear and the predisposition of turfgrass to environmental and biotic stresses. Table 1 provides a list of some of the many complex factors considered by golf course superintendents as they strive to manage healthy turfgrass. Although not shown here, similar lists for sports turfgrass mangers and lawn care specialists could also be developed.

Table 1. The Complexity of Factors Considered When Managing High Maintenance Turfgrass (e.g., Golf Course).

Factor:	Specific areas of concern:
Human Relations	Client Relations * Crew Size and Organization * Human Error * Language/ Ethnicity Dynamics * Experience Level of Employees * Expectations & Opinions * Amount of Play/Use
Budget	Staff * Equipment * Management options * Revenue Generation * Cost Recovery
Equipment	Irrigation System Characteristics * Mowers * Sprayers and Spreaders* Injection Equipment
Environment	Weather * Shade * Thatch * Air Movement * Water Dynamics * Temperature * Soil or Rootzone Mix Characteristics * pH * Soil Compaction
Agonomics	Fertility * Mowing * Air Movement * Irrigation * Thatch * Core Cultivation * Heat Stress * Drainage * Shade/Sunlight * Trees & Flowers * Wear * Playability * Aesthetics * Compaction * Topdressing* Hard Surface Maintenance * Traffic * Syringing * Turfgrass Selection * Water Quality * Repair * Mulching * Soil Type * Age of Sward/Facility/Lawn
Pathogens & Pests	Diseases * Insects * Grassy and Broadleaf Weeds * Wildlife Management * Regulatory Concerns * Product Availability & Selection * Rates & Means of Delivery * Environmental Stewardship

Diagnosing Turfgrass Problems

Proper diagnosis is a critical step in the management of plant diseases. Without a solid diagnosis, it is impossible to suggest or develop an adequate management strategy. As with most things, the more you know, the better equipped you will be to take corrective action. In the case of turfgrass disease diagnosis, the more you know about the host, environmental, and biotic factors that favor disease development (the disease triangle), the greater likelihood of making a correct diagnosis. The following 5-step approach is but just one of many approaches available for diagnosing turfgrass problems. Be open minded and don't make a situation fit into a predetermined disease.

1. **Define the problem.** Gather as much information as possible about the situation such as grass species, cultivar or variety, age of the stand, recent fertilizer or pesticide applications made, cultural practices implemented, weather trends, irrigation practices, use of growth regulators, history of problems, etc. It is essential to correctly identify the plant affected and to be familiar with its healthy state and characteristics. Make sure to take seasonal effects into account. For example, rough bluegrass (*Poa trivialis*) turning brown during the heat of the summer (going dormant) or Zoysiagrass (*Zoysia japonica*) turning brown after frost or cool temperatures in the fall are normal responses to the environment. Creeping bentgrass (*Agrostis stolonifera*) going brown in May is another story. Know your hosts and how they change with the seasons; only then can you determine that a problem exists.

2. **Examine the entire turfgrass plant community.** Don't jump right into examining the affected individual plant or area. Observe the entire plant community. For example, if you are making a trip to a golf course to examine a potentially diseased fairway, take notice of other golf courses along the way. Make a few calls to other golf course superintendents within close proximity of the golf course in question. Once at the course, observe other fairways to see how widespread the damage is. Once at the affected fairway, take a minute to look at the entire fairway. Take note of light conditions, wind direction, slope of the land, air movement, soil conditions, etc. Once you have done this, focus your attention on the affected plant(s) or area. Examine the leaves, stems, crowns and roots. Be thorough in making observations and avoid quick decisions or a snap diagnosis.

3. **Patterns — Diseases don't occur in straight lines!** Look for patterns. Is only a single plant affected? Is the problem restricted to a certain area or a single species? Are the symptoms randomly distributed or can you see distinct patterns or clear lines of demarcation between healthy and affected plants? Is the damage occurring in a pattern consistent with recently performed maintenance practices? Random patterns often are indicative of diseases or insect pests whereas uniform damage such as streaks or lines or damage over a large area is indicative of an abiotic (chemical, physical, or mechanical) culprit.

4. **Timing of events** — How did the problem develop? Did it appear suddenly or over time? Has the damage spread or stayed in the same location? Does the damage coincide with changes in the weather? Progressive development and spread of a problem over time often is associated with a pest or pathogen. Acute damage or that which occurs suddenly is more typical of that caused by abiotic factors such as environmental stress, mechanical damage (such as that caused by mowers, topdressing, abrasive sand, etc.) or chemical injury.

5. **Look for evidence of a pathogen or pest activity.** Specifically, look for key diagnostic signs or symptoms that are indicative of pathogens or insect pests. For instance, the presence of large numbers of fruiting bodies or mycelium might lead one to suspect a fungal infection. If after you have gathered sufficient background information and nothing strikes you as being obvious such as a chemical misapplication and have eliminated the possibility of pathogens and insect pests, retrace your steps and focus your diagnosis on abiotic factors. This is where things get tough and you may need to enlist the services of a plant pest or disease diagnosis laboratory to help narrow the range of probable causes. Whenever possible include photographs or digital images to aid the diagnostician in their task.

Seeking Professional Help

Ohio has a state-of-the art turfgrass diagnostic lab that is a multidiscipline clinic and provides complete diagnostic services. The Ohio State University plant diagnostic clinic is called The C. Wayne Ellett Plant and Pest Diagnostic Clinic (CWEPPDC).

The clinic address is:

PPDC
Room 201
2021 Coffey Road
Columbus, Ohio 43210/1375
Phone: (614) 292-5006
http://ppdc.osu.edu

The accuracy of any diagnosis depends on the information you supply, the plant material you select, and the condition in which it arrives. Collect specimens at the time the symptoms are still fresh and before fungicide treatments are made. Do not add water to the sample and, if the soil is saturated, allow to dry before sending. Samples should contain healthy and abnormal turfgrass. It is almost impossible to diagnose a grass sample that is nearly or entirely dead. Grass samples should be at least 6 by 6 inches and 2 inches deep, and should contain an intact layer of soil below the thatch layer. For golf course superintendents a cup cutter works well.

Rapid delivery of the sample and the turfgrass specimen form (see page 6) to the clinic is essential. If the sample is to be mailed, it is best to get a Plant and Pest Diagnostic Clinic Turf specimen form (there is a specific form for turf) from your county extension educator, the website (http://ppdc.osu.edu) or copy page 6, and fill the form out completely. The crucial questions you need to answer are: What are the symptoms and when were they first noticed? What, when, and which fungicides, insecticides, herbicides, and fertilizers were applied? Include photographs if possible and/or send digital images to the clinic. See the website for e-mail address.

Wrap the turf sample securely in several layers of newspaper or aluminum foil; then pack it tightly in the mailing carton to avoid contamination of the leaves with soil particles. Fill empty spaces in the box with wadded paper or packing material. If not using an overnight delivery service mail early in the week to avoid packages remaining in the post office over the weekend. You may want to call and notify us that a sample is being sent so you can be contacted when the sample has arrived.

TURFGRASS SAMPLE FORM

C. Wayne Ellett PLANT AND PEST DIAGNOSTIC CLINIC
201 Kottman Hall
2021 Coffey Road
Columbus, OH 43210-1087
PHONE: 614-292-9283 **FAX:** 614-292-4455
E-MAIL: ppdc@cfaes.osu.edu
WEBSITE: http://ppdc.osu.edu

Office Use Only
Sample # _____
Date Rec. _____
Amt. Rec. _____
Ck. # _____
Ser Amt. _____

CONTACT:

Name: _____
Company: _____
Address: _____
_____
_____
Phone: _____
Fax: _____
E-mail: _____

SEND RESULTS TO:

☐ Contact ☐ OSUE Educator ☐ Other

BILL TO:

☐ Contact ☐ OSUE Educator ☐ Other

Other: _____
_____
_____

COUNTY SAMPLE FROM: _____

Extension Educator: _____

Educator County: _____

PROVIDE INFORMATION FOR DIAGNOSIS *(Use reverse side as needed.)*

Turfgrass(s) and % of stand: ☐ Kentucky bluegrass _____% ☐ perennial ryegrass _____% ☐ fine fescue _____%
☐ tall fescue _____% ☐ *Poa annua* _____% ☐ creeping bentgrass (variety: _____) _____%
☐ other _____

Turf Established: ☐ seeded ☐ sodded **Age:** _____ **Soil Type:** ☐ sand ☐ loam ☐ clay ☐ other _____

Soil Conditions: ☐ wet ☐ dry **Drainage:** ☐ poor ☐ good **Soil Compaction:** ☐ yes ☐ no **Irrigation:** ☐ yes ☐ no

Type of Irrigation and when does it run? _____

Turfgrass Use: ☐ home lawn ☐ golf *(*☐ *green* ☐ *tee* ☐ *fairway* ☐ *rough*) ☐ sports *(which?)* _____
☐ other _____

Date Symptoms Noticed: _____ Has the problem happened before? ☐ yes ☐ no When? _____

Weather *(when problem started)*: **Rainfall:** ☐ wet ☐ dry ☐ average **Temperatures:** days _____°F nights _____°F

Light Conditions: ☐ full sun ☐ partial shade ☐ full shade % sunlight _____ Receiving morning sunlight? ☐ yes ☐ no

Current Conditions: Rainfall: ☐ wet ☐ dry ☐ normal **Temperatures:** days _____°F nights _____°F

Maintenance: mowing frequency _____ height _____ core cultivation *(last date)* _____ topdressing frequency _____

Symptoms *(Patterns on affected turfgrass)*: ☐ circles ☐ streaks ☐ spots ☐ large areas ☐ random thinning
☐ other _____

Suspected Problems: _____

Chemical Applications: List fungicides used, rates, and dates of applications. List other chemicals applied.

_____

Fertilizer Program: Rate: _____ lbs of N / 1000 sq. ft. per year **Date** *(of last application and rate)*: _____

Home Lawns: lawn service? ☐ yes ☐ no number of apps this year _____ when? _____
do-it-yourself program? ☐ yes ☐ no number of apps this year _____ when? _____

DESCRIBE SYMPTOMS AND PROVIDE ANY ADDITIONAL INFORMATION. *(Continue on back.)*

_____

Include photos and / or sketches of the affected plants and areas. Remember a picture is worth 1000 words!

01/21/2010

Integrated Management of Turfgrass Diseases

Why Turfgrass Turns Brown? The main reasons for brown turfgrass are adverse environmental factors such as "poor" soils, unfavorable climatic conditions, excessive wear, and improper maintenance. Turfgrass pathogens and pests, alone or in tandem with environmental (abiotic) factors, also significantly impact turfgrass quality. Although turfgrass managers can do little to influence regional weather patterns or regulate the amount of play or use on a given sward (a lawn composed of grass or other ground cover) of turfgrass, they are responsible for the management practices they implement. Maintenance practices that favor turfgrass growth over pathogen activity results in lower disease pressure and are considered the foundation of an effective turfgrass health management program (Figure 2).

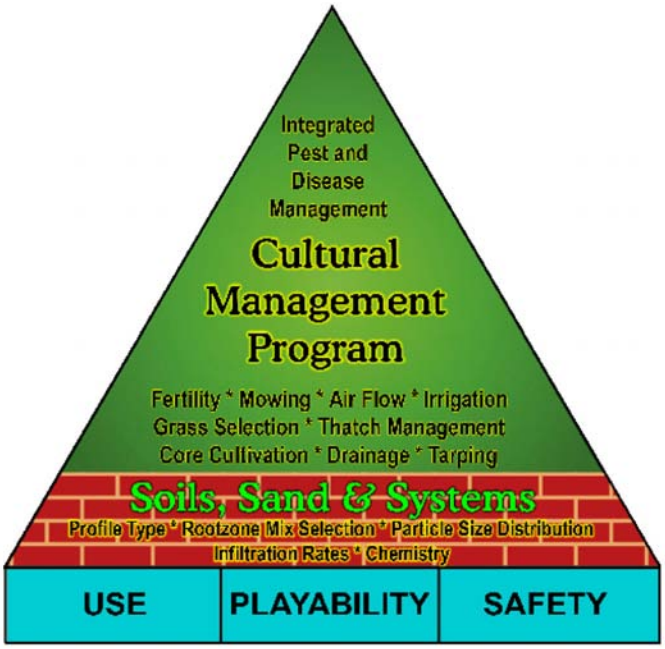

Figure 2. A model of key Integrated Turfgrass Health Management (ITHM) factors.

Most turfgrass diseases are caused by fungi and fungal-like organisms (Oomycetes such as *Pythium*). One convenient, albeit not absolute way, to classify turfgrass diseases is to do so based on the part of the plant being attacked (i.e., foliage; foliage and crowns; crowns and roots). Table 2 lists the major diseases caused by fungi and Oomycetes. There is only one economically important turfgrass disease caused by a bacterium (bacterial wilt).

Likewise, there is only one economically important turfgrass disease caused by a virus (St. Augustinegrass Decline). Nematodes may also cause significant losses in turfgrass, especially in tropical and subtropical climates. The impact of nematode feeding on cool-season grasses in temperate regions (like Ohio) is less well understood.

Table 2. Turfgrass Diseases Caused by Fungi and Oomycetes

Foliar Diseases

Dollar spot (*Sclerotinia homoeocarpa*)
Gray leaf spot (*Pyricularia grisea*)
Gray snow mold (*Typhula species*)
Pink patch (*Limonomyces roseipellis*)
Pink snow mold/ Microdochium patch (*Microdochium nivale*)
Powdery mildew (*Erysiphe graminis*)
Red thread (*Laetisaria fuciformis*)
Rust (*Puccinia species*)
Smut (numerous genera)
*Yellow tuft or downy mildew (*Sclerophthora macrospora*)

Foliar and Crown Diseases

Anthracnose (*Colletotrichum graminicola*)
Brown patch (*Rhizoctonia solani*)
Leaf spot/melting out (*Bipolaris*, *Drechslera*, and *Exserohilum* species)
*Pythium blight (*Pythium aphanidermatum*)
Red leaf spot (*Drechslera erythrospila*)
Yellow patch (*Rhizoctonia cerealis*)

Crown and Root Diseases

Dead spot (*Ophiosphaerella agrostis*)
Bermudagrass decline (*Gaeumannomyces graminis* var. *graminis*)
Fairy ring (numerous Basidiomycete fungi)
Necrotic ring spot (*Ophiosphaerella korrae*)
Seedling disease and damping-off (**Pythium*, *Fusarium*, *Microdochium* and *Rhizoctonia* species)
Spring dead spot (*Gaeumannomyces graminis* var. *graminis*, *Ophiosphaerella narmari*, *O. korrae* and *O. herpotricha*)
Summer patch (*Magnaporthe poae*)
Take-all patch (*Gaeumannomyces graminis* var. *avenae*)

* Oomycete diseases

As pressures mount to reduce inorganic fertilizer and pesticide inputs on turfgrass, interest has increased regarding the development and use of integrated pest management (IPM) programs that either forego or limit the use of pesticides. Although voluntary in some situations, fungicide use is prohibited or strictly regulated in other situations such as in the case of home lawn or residential turfgrass disease management.

The first line of defense to preventing or minimizing disease is through the selection and/or use of disease resistant turfgrass species/cultivars and the use of certified seed. Information regarding disease resistant turfgrass may be obtained by contacting local seed distributors, extension specialists and via the National Turfgrass Evaluation Program (NTEP; http://www.ntep.org). The use of genetically resistant turfgrass should be considered when establishing or renovating turfgrass areas or in situations where overseeding is used.

The second line of defense against turfgrass diseases is the use of cultural management practices that favor turfgrass health over pathogen activity. Cultural practices related to seedbed preparation prior to establishment are critical for seedling and root diseases such as Pythium damping-off and the patch diseases. Sand-based rootzone mix considerations for putting greens and athletic fields are equally critical. Under certain situations, it may be possible, although difficult, to modify poor quality soil conditions under existing turfgrass swards through the use of core aerification and organic matter topdressing programs. Disease management in established turfgrass swards is often achieved by modifying cultural management practices such as mowing, watering, fertilization, tree pruning, topdressing and core aeration. As mentioned previously, intensively managed turfgrass is often more predisposed to environmental and biotic stresses and so it is crucial that agronomic practices be timed to optimize turfgrass health. By providing growing conditions that favor plant growth over pathogen development or activity, it is possible to minimize or avoid disease.

Plant pathologists have developed a simple model called "**The Disease Triangle**" to illustrate this concept (Figure 3). Practices which influence the temperature, moisture and fertility status of the turfgrass have the greatest impact on disease development.

Fungicide applications are often essential where there is a demand for high quality turfgrass during environmental periods that favor pathogen growth. In general, fungicides are most effective when applied prior to the onset of disease symptoms (referred to as preventive applications). Fungicides applied after the onset of disease symptoms are typically made to slow or stop pathogen activity and to protect asymptomatic or healthy turfgrass. These type of applications are referred to as being curative. Keep in mind the pathogen is not killed with curative applications.

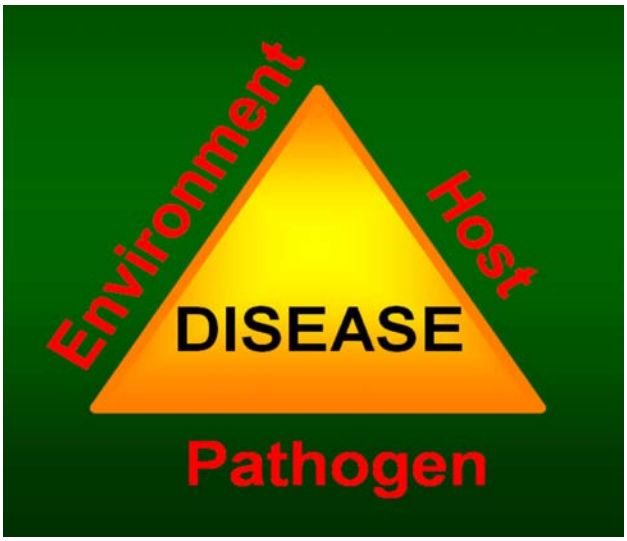

Figure 3. The Disease Triangle — when the pathogen is present, the host is susceptible and environmental conditions correct, you end up with DISEASE!

Other considerations for effective use of fungicides include: (a) selection of product; (b) use of proper water volume (i.e., minimum of 2 gallons per 1,000 ft^2); and (c) nozzle selection (for liquid applications).

Always read and follow label recommendations when applying fungicides as with any pesticide. Tables 3, 4, and 5 provide detailed information about fungicides and nematicides used to manage turfgrass diseases.

Several recent advances in the use of biolobical control stragegies to manage turfgrass diseases have been reported, such as the applicaiton of composts and the use of antagonistic microorganisms. Relatively few products are commercially available that provide consistent and predictable reductions in disease. To see if a product is registered as a commercial biocontrol, check this web site:

http://www.oardc.ohio-state.edu/apsbcc/

Use the side bar link "Product List." Questions worth asking when considering the use of biological control products on turfgrass are provided in Table 7.

Summaries of integrated management strategies for turfgrass disease commonly encountered in Ohio are provided in Table 3.

Table 3. Integrated Management of Turfgrass Diseases in Ohio

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Algae (Blue-green algae/ cyanobacteria)	All turfgrass species (Throughout the growing season)	1) Reduce shade. 2) Avoid excessive or low fertilization. 3) Improve soil drainage. 4) Alleviate compaction. 5) Mow high to increase density.	Mancozeb Chlorothalonil
Anthracnose (can be a foliar blight or a rotting of the basal tissue) (*Colletotrichum graminicola*)	ANNUAL BLUEGRASS (all seasons) Bentgrass Fine fescue Ryegrass Bluegrass (for these, summer–fall)	1) Avoid scalping and mowing stress. 2) On greens raise the mowing height. 3) Avoid over watering. 4) Improve drainage, surface and internal. 5) Fertilize to maintain growth & vigor. 6) When disease is active avoid all maintenance that wounds the plants. 7) Aerate and improve root growth.	Iprodione Thiophanate-methyl Fenarimol Myclobutanil Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Chlorothalonil Fludioxonil Polyoxin D zinc salt
Brown patch (*Rhizoctonia solani*)	BENTGRASS TALL FESCUE Ryegrass Bluegrass (summer)	1) Avoid excessive nitrogen fertilization in summer. 2) Increase air circulation. 3) Avoid excessive watering. 4) Select turfgrass species & cultivars with resistance.	Mancozeb Thiram Iprodione Vinclozolin Thiophanate-methyl Fenarimol Myclobutanil Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Flutolanil Chlorothalonil PCNB Fludioxonil Polyoxin D zinc salt
Copper spot (*Gloeocercospora sorghi*)	Creeping bentgrass (summer)	1) Maintain adequate fertility growth but avoid excessive nitrogen fertilization in summer. 2) Avoid excessive watering. 3) Promote drying of turfgrass.	Mancozeb Thiophanate-methyl Fenarimol Myclobutanil Triademefon Tebuconazole Chlorothalonil
Dead spot (*Ophiosphaerella agrostis*)	CREEPING BENTGRASS Bermudagrass (fall, winter & spring damage is long lasting)	1) May occur on the newer creeping bentgrass cultivars. 2) A newly identified disease; research is being conducted on how to manage.	Pyraclostrobin Boscalid PCNB Fludioxonil
Dollar spot (*Sclerotinia homoeocarpa*)	BENTGRASS BLUEGRASS Ryegrass Fescues (late spring–late fall)	1) Avoid nitrogen deficiency. 2) Remove dew from grass, dragging, poling/caning, etc. 3) Provide adequate soil moisture to promote growth.	Thiram Iprodione Vinclozolin Thiophanate-methyl Fenarimol

continued -->

Table 3. Integrated Management of Turfgrass Diseases in Ohio (cont'd)

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Dollar spot cont'd (*Sclerotinia homoeocarpa*)		4) Select turfgrass species & cultivars with resistance.	Myclobutanil Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Boscalid Chlorothalonil PCNB
Fairy ring (Soil borne basidiomycete fungi)	All turfgrass species (all seasons)	1) Improve water penetration; core aeration, fork, wetting agents, etc. 2) Increase nitrogen fertilization to mask symptoms. 3) Remove infested sod, thatch and soil, replace with clean soil and reseed or sod.	Triademefon Azoxystrobin Pyraclostrobin Flutolanil Metconazole
Fusarium blight — see Necrotic ring spot and Summer patch			
Fusarium patch — see Pink snow mold/ Microdochium patch (When disease occurs without snow, it is referred to as Microdochium patch.)			
Gray leaf spot (*Pyricularia grisea*)	RYEGRASS Tall fescue (late summer–fall)	1) Avoid excessive soluble nitrogen in summer into early fall. 2) Avoid excessive watering. 3) Avoid excessive herbicide use and chemical stress. 4) Manage soil compaction. 5) Select turfgrass species & cultivars with resistance.	Thiophanate-methyl Triademefon Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Chlorothalonil Fludioxonil
Gray snow mold/ Typhula blight (*Typhula* species)	BENTGRASS BLUEGRASS Perennial ryegrass Fescues (late fall, winter & early spring)	1) Avoid heavy fall nitrogen applications to prevent late lush growth. 2) Control drifting snow to minimize snow cover. 3) Rake leaves and cut short going into winter.	Thiram Iprodione Vinclozolin Fenarimol Triademefon Propiconazole Triticonazole Tebuconazole Azoxystrobin Pyraclostrobin Fluoxastrobin Flutolanil Chlorothalonil PCNB Fludioxonil Polyoxin D zinc salt
Leaf spot/Blight/Melting out (*Drechslera, Bipolaris*, & *Exserohilum* species.)	COMMON KENTUCKY BLUEGRASS All other turfgrass species (leaf spot: spring & fall) (blight & melting out: summer)	1) Raise cutting height. 2) Avoid excessive nitrogen. 3) Avoid light frequent watering, prolonged wet leaves. 4) Avoid excessive herbicide stress	Mancozeb Thiram Iprodione Vinclozolin Thiophanate-methyl Myclobutanil Propiconazole Triticonazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Chlorothalonil PCNB Fludioxonil Polyoxin D zinc salt

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Table 3. Integrated Management of Turfgrass Diseases in Ohio (cont'd)

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Nematodes (Plant-parasitic) (Various genera)	All turfgrasses — especially in tropical climates. (summer & fall)	1) Fertilize and to maintain vigor. 2) Manage water to avoid stress. 3) Promote plant growth and vigor.	Fenamiphos
Necrotic ring spot (*Ophiosphaerella korrae*)	KENTUCKY BLUEGRASS (especially 3–4 + year old sod) Annual bluegrass Rough bluegrass Fine Fescue (spring & fall)	1) Prepare site to maximize rooting of sod. 2) Avoid low mowing heights (below two inches). 3) Reduce excessive thatch (over 3/4 inch) and compaction through frequent heavy core aerate. 4) Use Kentucky bluegrass and perennial ryegrass mixtures to repair damaged areas. 5) Improve soil drainage. 6) Avoid excessive watering or drought stress. 7) Use slow release nitrogen, the goal is to evenly fertilize the turfgrass all year. Avoid excessive or rapid leaf growth.	Iprodione Thiophanate-methyl Fenarimol Myclobutanil Propiconazole Triticonazole Tebuconazole Azoxystrobin
Pink patch (*Limonomyces roseipellis*)	RYEGRASS (spring & fall) Bentgrass	1) Provide an adequate fertilization program to promote growth. 2) Core aerate to reduce soil compaction, manage thatch and improve turfgrass health.	Propiconazole Triticonazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Flutolanil
Pink snow mold/ (**Microdochium patch** without snow) (*Microdochium nivale*)	ANNUAL BLUEGRASS BENTGRASS Bluegrass Fine fescue Ryegrass Tall fescue (fall, winter & spring)	1) Avoid heavy fall nitrogen applications to prevent late lush growth. 2) Control drifting snow to minimize snow cover. 3) Rake leaves and cut short going into winter.	Mancozeb Thiram Iprodione Vinclozolin Thiophanate-methyl Fenarimol Myclobutanil Triademefon Propiconazole Triticonazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin PCNB Fludioxonil Polyoxin D zinc salt
Powdery mildew (*Erysiphe graminis*)	BLUEGRASS Fescues (Throughout the growing season)	1) Reduce shade. 2) Increase air circulation to dry turfgrass foliage. 3) Use resistant Kentucky bluegrass cultivars.	Fenarimol Myclobutanil Triademefon Propiconazole Tebuconazole Azoxystrobin Pyraclostrobin

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Table 3. Integrated Management of Turfgrass Diseases in Ohio (cont'd)

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Pythium blight (*Pythium aphanidermatum*)	BENTGRASS RYEGRASS Bluegrass Fescues Especially all juvenile and lush turfgrass. (summer)	1) Improve soil drainage. 2) Increase air circulation to promote drying. 3) Avoid mowing wet grass. 4) Avoid excess watering. 5) Manage turfgrass to prevent lush rapid growth.	Cyazofamid Fluopicolide Mefenoxam Propamocarb Chloroneb Ethazole Azoxystrobin Pyraclostrobin Fluoxastrobin Fosetyl-Aluminum Phosphites (salts of phosphorous acid)
Pythium root rot (*Pythium* species)	ANNUAL BLUEGRASS BENTGRASS (spring & fall)	1) Improve soil drainage. 2) Increase mowing height.	Cyazofamid Fluopicolide Mefenoxam Ethazole Azoxystrobin Fosetyl-Aluminum
Red leaf spot (*Drechslera erythrospila*)	BENTGRASS (summer)	1) Remove clippings. 2) Fertilize to maintain vigor.	See leaf spot materials list.
Red thread (*Laetisaria fuciformis*)	RYEGRASS FINE FESCUE Bluegrass All grasses can occasionally be damaged. (all seasons / most common during mild weather)	1) Fertilize to maintain vigor and increase growth. 2) Check for phosphorous deficiencies. 3) Promote growth by aeration, watering, etc. 4) Select turfgrass species & cultivars with resistance.	Mancozeb Iprodione Vinclozolin Thiophanate-methyl Myclobutanil Fenarimol Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Flutolanil Chlorothalonil Polyoxin D zinc salt
Rust (*Puccinia* species)	RYEGRASS Bluegrass (summer–fall)	1) Avoid nitrogen deficiency. 2) Use resistant varieties of Kentucky bluegrass and perennial ryegrass. 3) Water if dry, promote growth. 4) Alleviate compaction, increase growth.	Thiophanate-methyl Myclobutanil Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Chlorothalonil
Seedling damping-off (primary pathogens are *Pythium* and *Rhizoctonia*)	All grasses (mainly in summer)	1) The primary concern is seeding in hot, wet summer conditions. 2) Manage watering to prevent waterlogged soil.	See fungicides listed under Pythium Blight and Rhizoctonia Blight/ brown patch. Seed may be treated with Metalaxyl (Apron) for *Pythium*.

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Table 3. Integrated Management of Turfgrass Diseases in Ohio (cont'd)

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Slime molds (Myxomycetes)	All turfgrass species (Throughout the growing season)	1) Remove by mowing or raking. 2) Manage thatch at low levels.	Mancozeb
Snow mold — see Gray snow mold and Pink snow mold / Fusarium patch			
Smuts (*Ustilago* species & *Urocystis* species)	KENTUCKY BLUEGRASS Bentgrass (spring & fall)	1) Avoid drought stress. 2) Avoid excessive nitrogen. 3) Use resistant varieties of Kentucky bluegrass.	Thiophanate-methyl Triademefon Propiconazole Tebuconazole *Note*: Increase spray volume for crown penetration. Apply in late fall and/or early spring.
Spring dead spot (*Gaeumannomyces graminis* var. *graminis*, *Ophiosphaerella narmari, O. korrae* & *O. herpotricha*)	Bermudagrass (spring–early summer)	1) Avoid late summer nitrogen fertilization or after Labor Day. 2) Raise moving height before Labor day. 3) Manage thatch to a minimal level. 4) Maintain soil pH as close to 5.2–5.3 as is possible. 5) Midsummer aerification programs improve turfgrass health and may decrease disease pressure.	Thiophanate-methyl Fenarimol Myclobutanil Propiconazole Tebuconazole Azoxystrobin Fluoxastrobin
Summer patch (*Magnaporthe poae*)	ANNUAL BLUEGRASS KENTUCKY BLUEGRASS Fine fescue (summer)	1) Avoid low mowing and thatch buildup. 2) Maintain soil pH between 6 & 7. 3) Light, frequent watering during dry periods to reduce heat stress. 4) Use slow-release nitrogen. 5) Use Kentucky bluegrass and perennial ryegrass mix. 6) Avoid compaction.	Thiophanate-methyl Fenarimol Myclobutanil Triademefon Propiconazole Triticonazole Metconazole Tebuconazole Azoxystrobin Trifloxystrobin Pyraclostrobin Fluoxastrobin Polyoxin D zinc salt
Take-all patch (*Gaeumannomyces graminis* var. *avenae*)	BENTGRASS (spring & fall – symptoms in summer)	1) Use acidifying fertilizers to lower pH. 2) Avoid heavy rates of lime. 3) Remove patches and resod. 4) Avoid excess nitrogen fertilization.	Thiophanate-methyl Fenarimol Myclobutanil Triademefon Propiconazole Triticonazole Tebuconazole Azoxystrobin Pyraclostrobin Fluoxastrobin *Note*: materials work best if applied preventively and with high water volume - 4 gal / 1000 ft^2

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Table 3. Integrated Management of Turfgrass Diseases in Ohio (cont'd)

Disease (pathogen)	**Susceptible Species**[1] (season)	**Maintenance Comments**	**Fungicide(s)** Common Name[2]
Typhula blight — see Gray snow mold			
Yellow patch (*Rhizoctonia cerealis*)	Bentgrass Bluegrass (all seasons)	1) Reduce excessive thatch. 2) Avoid excessive watering. 3) Improve soil drainage.	Thiophanate-methyl Propiconazole Triticonazole Azoxystrobin Flutolanil Fludioxonil Polyoxin D zinc salt
Yellow tuft / Downy mildew (*Sclerophthora macrospora*)	Bentgrass (spring, summer & fall)	1) Improve soil and surface drainage. 2) Vertical cutting may help remove plants and smooth the surface.	Mefenoxam Pyraclostrobin Fosetyl-Aluminum

[1] Grass types listed in capital letters have been observed to be especially susceptible to the pathogen.
[2] Products containing these active ingredients are listed in Table 5. Refer to this table for product Trade Names. Read the product label to see if it is labeled for the disease of concern.

Table 4. Combination Fungicide Products

Product Name	**Active Ingredients**
Armada	triadimefon + trifloxystrobin
Concert	propiconazole + chlorothalonil
ConSyst, Spectro, Peregrina	thiophanate-methyl + chlorothalonil
Disarm C	fluoxastrobin + chlorothalonil
Headway	azoxystrobin + propiconazole
Honor	pyraclostrobin + boscalid
Instrata	propiconazole + chlorothalonil + fludioxonil
Junction	copper hydroxide + mancozeb
LESCO Twosome	fenarimol + chlorothalonil
MANhandle	myclobutanil + mancozeb
Prostar Plus	triadimefon + flutolanil
Proturf Fluid Fungicide	iprodione + thiophanate-methyl
Proturf Fluid Fungicide II	metalaxyl + triadimefon
Proturf Fluid Fungicide III	triadimefon + thiram
Proturf Fungicide IX	thiophanate-methyl + chloroneb
Renown	azoxystrobin + chlorothalonil
Reserve	triticonazole + chlorothalonil
Systar	thiophanate-methyl + flutolanil
Stellar	fluopicolide + propamocarb
Tartan	triadimefon + trifloxystrobin + stress guard
26/36 Fungicide	iprodione + thiophanate-methyl

Table 5. Trade Names of Turfgrass Fungicides and Nematicides

Active Ingredient (Common Chemical Name)	**Products Registered for Turfgrass Use** Trade Name(s)[1]
Fungicides	
Azoxystrobin	Heritage
Boscalid	Emerald
Chloroneb	Tersan SP
Chlorothalonil[2,3]	Daconil, Manicure, Echo, Pegasus, Pentathalon, Chlorostar
Cyazofamid	Segway
Ethazole (Etridiazole)	Terrazole, Koban
Fenarimol	Rubigan
Fludioxonil	Medallion
Fluoxastrobin	Disarm
Fluopicolide[4]	Steller (with Propamocarb)
Flutolanil	ProStar
Fosetyl-Aluminum	Chipco Signiature, Prodigy, Aliette
Iprodione[2]	Chipco 26GT, Iprodione Pro, 18 Plus
Mancozeb	Fore, Formec, Dithane, Mancozeb, Protect T/O, Pentathlon
Mefenoxam	Subdue
Metalaxyl	Apron (seed treatment)
Metconazole	Tourney
Myclobutanil	Eagle, Golden Eagle
PCNB (Pentachloronitrobenzene)	Terraclor, Turficide, FFII, PCNB, Penstar, Defend, Revere
Phosphite	Magellan, Biophos, Resyst, Alude, Vital
Polyoxin D zine salt	Endorse
Propamocarb	Banol
Propiconazole	Banner, Propiconazole Pro, Spectator
Pyraclostrobin	Insignia
Tebuconazole	Torque
Thiophanate-methyl	Fungo, Cleary's 3336, T methyl Pro, T-Storm
Thiram[2]	Spotrete, Thiramad, Thiram
Triadimefon	Bayleton, Accost
Trifloxystrobin	Compass
Triticonazole	Trinity
Vinclozolin[2]	Touché, Curalan
Nematicides	
Fenamiphos	Nemacur

[1] Many products may be available only through specialized dealers or only in large quantity. Some products can be purchased and applied only by licensed pesticide applicators. Products with other trade names may be available.

[2] These products will be no longer labeled for residential turfgrass, read the label carefully.

[3] All Chlorothalonil products in the future will have maximum application rate and annual use guidelines, follow the label. Other fungicides also have maximum amounts of product and or number of applications per acre per year. Read the label carefully and follow all instructions.

[4] In a new chemical class, acylpicolides, for *Pythium*.

Table 6. Biocontrol Products

Active Agent (Biological Organism)	**Product Name**
Bacillus licheniformis	EcoGuard
Bacillus subtillis, strain QST 713	Rhapsody
Trichoderma harzianum	Bio-Trek, Turfshield, TurfMate

Several recent advances in the use of biological control strategies to manage turfgrass diseases have been reported, such as the application of composts and the use of antagonistic microorganisms. Relatively few products are commercially available that provide consistent and predictable reductions in disease. To see if a product is registered as a commercial biocontrol check this site:

http://www.oardc.ohio-state.edu/apsbcc/

and use the side bar link "Product List". Questions worth asking when considering the use of biological control products on turfgrass are provided in Tables 6 and 7.

Table 7. Questions Worth Asking When Considering the Use of Microbials on Turfgrass

Approach microbial products with a healthy dose of skepticism — not a negative attitude. Use common sense, sound judgment, and ask lots of questions.

1. Is the product making pesticidal claims?

If yes — Is the product EPA registered? This is the law if they are making pesticidal claims. If they are making pesticidal claims and the product is not EPA registered, they are breaking the law. The US EPA Office of Pesticide Programs offers an online list of all products registered or for which Experimental User Permits (EUP's) have been issued. You can access this site at:

http://www.epa.gov/pesticides/biopesticides/

If no — The product is not considered a pesticide and does NOT require EPA registration. When in doubt, contact your state department of agriculture or EPA representative.

2. What does the product do?

How does the product work? What does the product actually do? For biological control products this might include asking whether suppression is general (control by many organisms — i.e., competition) or specific (caused by one or a few organisms) or inquiring about the specific mechanism or mode of action — i.e., competition, antibiotic production, hyperparasitism, or induced resistance.

3. Was the product tested?

Who tested the product (ask for names and telephone numbers)? Were the results published in a reputable scientific journal? Were the experiments confirmed by multiple researchers? Preferably tested at a university by known non-biased researchers. Contact a turfgrass pathologist and get their thoughts on the product as well. USE YOUR STATE EXTENSION SPECIALISTS!

4. Are others in the area using the product?

Don't just take a "yes" for an answer. Ask for references and give them a call to see what they think about the product. USE YOUR LOCAL NETWORK!

5. Will they supply you with enough product for testing under your conditions to substantiate their claims?

If the product is really new and you don't believe it has been tested enough in the field (based on what you find out in questions one through four above) then don't be shy about asking for a sample to evaluate on your turfgrass. Use COMMON SENSE and take a SOMEWHAT CONSERVATIVE approach when applying the product. For example, avoid making large-scale applications to your high value areas. Test the product out using small-scale applications making certain to include both non-treated and standard treated plots to enable you to fairly assess the efficacy of the new product or approach.

Ask questions...
Expect direct responses to your questions...
Use common sense when making applications...
Always include the appropriate control plots (not treated) for comparison purposes...

Managing Fungicide Resistance

Many disease organisms are very adept at developing genetic mechanisms that allow them to survive chemicals that are applied to control them. This is called pesticide resistance. Some species of fungi appear to be better able to develop this resistance and some fungicides, due to their particular mode of action, are more susceptible to pathogens developing resistance.

The Fungicide Resistance Action Committee (FRAC) is a technical group whose goal is to provide fungicide resistance management guidelines. Refer to Table 8 for additional information.

Table 8. FRAC — Fungicide Resistance Action Committee

FRAC is a Specialist Technical Group of CropLife International
(Formerly Global Crop Protection Federation, GCPF).

The purpose of FRAC is to provide fungicide resistance management guidelines to prolong the effectiveness of "at risk" fungicides and to limit crop losses should resistance occur. The main aims of FRAC are:

1. Identify existing and potential resistance problems.
2. Collate information and distribute it to those involved with fungicide research, distribution, registration and use.
3. Provide guidelines and advice on the use of fungicides to reduce the risk of resistance developing, and to manage it should it occur.
4. Recommend procedures for use in fungicide resistance studies.
5. Stimulate open liaison and collaboration with universities, government agencies, advisors, extension workers, dis tributors and users of products.

FRAC Code: Numbers and letters are used to distinguish the fungicide groups according to their cross resistance behavior. The numbers were assigned according to the time of product introduction to the market. The letters refer to P = host defense inducers, M = multi-site inhibitors, and U = unknown mode of action and unknown resistance risk.

For more information go to http://www.frac.info/frac/menu.htm

In Integrated Turfgrass Disease Management, it is often recommended to rotate between fungicide families, especially ones with different modes of action. If a fungicide ceases to perform at past levels, consider using a fungicide in a different family.