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Understanding Fungicides

Photo courtesy of BASF

Dollar spot.

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Before you can successfully implement fungicides into your disease management program, you've got to get to know them.

TABLE 1.

Factors That Can Affect Turf and Pest Management

1. Mowing
2. PGR (growth inhibitors)
3. Clippings
4. Topdressing
5. Irrigation
6. Fertilization
7. Overseeding
8. Sodding
9. Herbicides
10. Shading
11. Surfactants
12. Nematicides
13. Insecticides
14. Aerification
15. Compaction
16. pH
17. Seed mixtures
18. Seed blends
19. Weeds
20. Drainage
21. Organic amendments
22. Soil amendments
23. Biological agents
24. Growth stimulators
25. Heat
26. Irradiation
27. Humidity/wetness
28. Fungicides

What are fungicides? The popular definition: fungicides are any chemical that can inhibit the growth or development of a fungus. The technical definition: fungicides are any chemical that kills a fungus. *Fungistats* are chemicals that *inhibit*, but do not kill, the fungus. In the turfgrass industry, the term fungicide is commonly used for any chemical that reduces or prevents the development of a fungal disease, but this is much different than the true action of a fungicide. There are many ways chemicals can inhibit or kill a fungus, and there are many different fungi, each of which can react differently to the various fungicides you apply to turf. Further, the effectiveness of a fungicide is determined by much more than just its chemical nature. In short, there is a lot to understand about fungicides if you want to maximize their effectiveness.

Fungi Hit List

There are about 25 different fungi that cause serious turfgrass diseases. There are many more fungi that can attack or infect turfgrasses, but they seldom cause noticeable damage. Why does nature allow the Big 25 fungi to attack turf? The simple reason is nature's balance: The fungi that "eat" the turf are food for other microbes that "eat" them. Beyond the Big 25 that attack your turf, there are thousands of other fungi that rot thatch, debris, other plants and microbes, all of which become organic nutrients for the turfgrass. We call these *beneficial fungi*. Every turf manager loves the beneficial fungi, but did you know that most of the Big 25 also are members of the beneficial class of fungi? Pythium (warm-temperature foliar blight): a great rotter of dead plants. Colletotrichum (anthracnose): another beneficial, debris-rotting fungus. And of course, all of the fairy-ring fungi live to rot thatch and dead plant material. In fact, only the obligate parasites (ones that must have a live plant to grow), which cause diseases like powdery mildew, smut and yellow tuft, are non-rotters.

So the question for turf managers is: How do I manage the fungal pathogens in my turf without stopping their beneficial rotting activity? If we did not mow, fertilize and groom the turf to fit our objectives, the answer would be very simple: walk away and leave the management to nature. This is not possible for turf managers. Turf is a population of natural plants growing

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in a population of soil microbes, forced by man to grow abnormally. You, the turf manager, are the reason that turf diseases become severe problems. Each year you manage a turf, most of the Big 25 diseases will occur. That's right, most of them develop in your turf each year. However, only occasionally do any of them become severe enough for you to even notice them, much less treat them. Diseases in turf are considered serious only if they are conspicuous and last for a considerable period of time. When asked, most turf professionals estimate that a disease is noticed only if it develops in 3-5% of the total turf. The goal of turfgrass disease management is to limit the severity of a disease to less than that. This is an enlightened goal because it acknowledges that disease is necessary and should not be eliminated from the ecology of the turf. In fact, turf with at least a low level of disease severity is more protected from severe disease outbreaks compared to turf without any disease development. The reason: *biological buffering*. When your soil has many different and active microorganisms in it, they tend to control one another. If you eliminate one of the players in this system, then the others must adjust. For example, if you were to selectively kill the fungi that naturally control pythium, then pythium fungi might grow unchecked and attack your turf. Nothing in turf is this simple, but it does illustrate biological buffering. *Biological control* is quite different than biological buffering. *Biological control* is the action by one living organism to suppress the activity of another. It is a natural process and, collectively, all the one-on-one episodes of biological control add up to biological buffering.

Adjusting the biological buffering of turf is a slow process. You should not attempt to rapidly change the biology of a turfgrass ecosystem. The ecosystem is very strong and resists changes because so many organisms are involved in it. However, you *can* change it; but if you change it too fast, you imbalance the entire system and havoc results. Here are two cases of how turf managers can upset the biological balance.

- **Case One:** Fumigation with methylbromide kills nearly all microbes, animals and plants. When you treat a soil with this chemical, all biological balance is eliminated. When you seed grass plants into such a soil, it will take months—maybe years—to reestablish biological balance. In the process, diseases like pythium blight, rhizoctonia blight and take-all patch will rapidly attack the young turf because there are few other microbes to inhibit them.
- **Case Two:** You apply a therapeutic or curative rate of a fungicide to control dollar spot fungus. Initially, the severity of dollar spot is reduced, but what you do not see are the many other changes in the microbial community that also are taking place. Nontarget fungi are also being inhibited, while other fungi are racing to fill the void created by these inhibited fungi. In short, the turf ecosystem is imbalanced and responds to the change brought about by the fungicide. Generally, fungicidal activity is greatly diminished two to four weeks after application, but some effects last much longer than that. At the University of Illinois, we have seen the effects of fungicides last more than 12 months following application for the control of dollar spot on bentgrass.

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Balancing Act

As turf managers, you are expected to produce a uniform and perfect turf, but all the forces of nature are going to fight you unless you harness them. So how do you approach turfgrass management using the concepts of biological buffering and ecological balancing? Can fungicides be a part of such a program? Good turfgrass management does not start with a fungicide. There are 28 factors you should consider when managing turf (see Table 1). These factors are not intended for

SELECTING SYSTEMICS

First and foremost, use a fungicide that is effective against the fungus that is causing the disease in your turf. They do not work equally against all fungi. It is very important that you develop your own information on the effectiveness of fungicides for your particular turf. One of the main differences among the active ingredients of systemic fungicides is mode of action—whether the chemical behaves as a contact or systemic. Before making your chemical selection, take into consideration the chemical's resistance risk—how likely it is that turf will develop a resistance to the chemical (see Table 2). Other things you should consider before deciding on a fungicide include:

- What disease do you want to control?
- What fungicides have good activity against "your" disease?
- Order the fungicides according to their resistance risk.
- Initially choose the most effective fungicide.
- If repeated applications of fungicide are needed during a single season, use another product with a different mode of action.
- If you are not achieving adequate disease control, review your situation with a turfgrass pathologist before you select or use other fungicides.

EFFECTIVE USE OF FUNGICIDES

- Realize that fungi are a necessary part of your turf ecology; you do not want to eliminate them, just manage them.
- Realize that disease management is just one component of turf management, and think seriously about integrated turf management.
- Make every effort to use as many of the first 27 management factors listed in Table 1 before moving to factor 28.
- When choosing a fungicide, think of it as a short-term solution to reestablishing the balance in your turf.
- Stop using a fungicide as soon as you can.
- Choose fungicides that are appropriate for the disease problem you have.
- *Always* use fungicides according to the manufacturer's recommendations. *Follow the label.*
- Consult a plant pathologist and review your disease management program.

only disease management, but should be considered for all aspects of turf management. I have purposely listed fungicides last (no. 28), as they should be the last factor you consider for disease management. Fungicides are only "needed" because of the lofty expectations for turf quality. However, the availability of fungicides and the increasing demand on turf managers for "perfect" turf has led many managers to rely on fungicides. I describe this as "fungicide addiction," and it will ultimately lead only to poor grass and anxiety.

• **Chemicals that are used as fungicides.** A number of fungicides are currently registered for use on turfgrass. Table 2 lists the resistance risk of systemic fungicides, which indicates the likeliness that a fungicide will perpetuate a genetic change (i.e., develop chemical resistance) in a fungus.

• **Contact fungicides for turfgrass.** Contact fungicides are an older type of fungicide. They are also known as protectants because they are intended to intercept a fungus and prevent it from attacking or infecting (getting inside) a grass plant. They do not penetrate plant tissues. They inhibit fungi by interfering with the growth and development of fungi in a number of ways, i.e., they are multiple-site inhibitors. As such, they create a very low risk that fungal resistance will develop. For a fungus to rapidly overcome the inhibition that a fungicide causes (develop resistance), it must change its DNA. In nature, changes in fungal DNA are brought about by several mechanisms. Most genetic changes that occur in fungi kill them, and these changes occur very infrequently. It has been estimated that only one in a million DNA changes (mutations) is not lethal, and most of these are rapidly eliminated from the fungus anyway. When a fungus has to change its DNA not just once, but two, three or four times, the chances of it accomplishing this are so rare that it will not happen. Contact fungicides remain effective even if you use them over and over again.

• **The repetition of contact fungicides.** Contact fungicides are toxic to many different fungi, including many of the nontarget fungi that are beneficial to your turf. In order to work, they must cover the plant surfaces before fungi attack. If the fungal pathogen attacks the leaves, it is easy to apply the contact fungicide to the leaves; but the leaves are growing and the new leaf tissue will be unprotected, so you'll have to apply the fungicide frequently. In the spring, this could be every week or even more often. If the fungal pathogen attacks the crown, rhizomes, stolons or roots, you'll encounter the same problem due to the growth of these tissues, but it is further complicated by the fact that they are surrounded by soil. Soil and organic matter will filter and bind many chemicals to their surfaces. This forces you to use more compound to achieve disease control.

• **Systemic fungicides for turfgrass.** Systemic fungicides are a newer class of fungicide, but they still have been around for 20 years. They are described as systemic because they "move" once applied to the turf and redistribute inside the plant. "Systemic" implies that the compound will move into *all* cells of the plant. If you apply it to the leaves it would end up in the roots; and if you applied it to the

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soil, it would end up in all the roots and the leaves. However, this is not always the case. Some fungicides are described as *locally systemic,* meaning they only move a few cells away from the point of entry. This is most likely the case for the majority of systemic fungicides. The application, delivery, incorporation, redistribution and action of systemic fungicides are a complicated science. Fungicides not only have different active ingredients, they also have different carriers. A *carrier* is the material upon which the active ingredient is loaded for the purpose of application. The carrier itself can have fungicidal activity and can greatly affect how the active ingredient reacts and enters a plant. Generally, companies that develop fungicides test many different carriers to determine which works the best. However, each type of grass has different surface chemistries, and each will react somewhat differently to a carrier. Sometimes, one fungicide is more effective than another because of the carrier, not the active ingredient.

As for translocation or systemic properties, don't overestimate this characteristic. In most cases, the movement of the compound, once applied, appears limited to very short distances within the plant. This is evident because fungicidal protection is quickly lost if the grass plant is actively growing or the pathogen is very aggressive. Another limitation with systemics is the time needed for full effectiveness to be realized. Generally, once applied, systemic fungicides require three to five days to become fully effective. The reason is simple: They must move into a plant, redistribute within the plant and build up enough active ingredient in the plant to have an effect. Each of these processes takes time, adding up to three to five days. I have observed systemic fungicides seemingly fail to control a disease that they are known to be effective against. If your disease pressure is increasing or at a high level when you apply the systemic fungicide, then during the three to five days required to reach full effectiveness, the pathogen can overrun the plant. Combine this with rapid turf growth or very poor turf growth and it will appear that the fungicide failed. This is often the case with the failure of systemic fungicides to control gray leaf spot. For a systemic fungicide to be effective, the disease severity at the time of application must be low. This does not mean you should use them preventatively; it means you have to scout your turf and look for the start of disease. This is why it is important to use as many of the 28 management factors (Table 1) as possible to slow down the rate of disease development.

TABLE 2.

Resistance Risk of Systemic Fungicides

Common Name	Resistance Risk
(benzimidazoles):	
benomyl	high
thiophanates	high
(phenylamide):	
metalaxyl	high
mefanoxam	high
(1,2,4-triazoles):	
myclobutanil	moderate
propiconazole	moderate
tebuconazole	(experimental)
triadimefon	moderate
triticonazole	(experimental)
(pyrimidinemethanol):	
fenarimol	moderate
(strobilurins):	
azoxystrobin	moderate
pyraclostrobin	moderate
trifloxystrobin	moderate
(dicarboximides):	
iprodione	moderate
vinclozolin	moderate
(analides):	
flutolanil	low
boscalid	moderate
(polyoxin):	
polyoxin D	moderate
(carbamate):	
propamocarb	low
(phosphonate):	
fosetyl-aluminum	low

* Some are single-site inhibitors (SSI); a few are multisite inhibitors (MSI). SSIs have moderate-to-high risk of fungicide resistance development.

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