Fungicides: *what they do (and don't)*

Your turf has a disease! What do you do? Reach for a fungicide? What kind? And what's the best way to use it? What exactly do fungicides do? How can I maximize my chance of getting a good result from a fungicide? There are several ways in which fungicides are classified: By when they are used, by how they move (or don't move) inside a plant, by their chemical structure, and by their mode of action (how they kill a fungus, or prevent it from growing).

TIME OF USE

Fungicides can be used both preventively, before any disease symptoms are present, and curatively, after disease occurs. This distinction is important because some fungicides are much better suited for one of these uses than others. For example, fungicides that work by activating a plant's natural defense responses to infection must be used preventively. By the time a disease is ravaging a plant, its defenses are already being overcome.

Although a fungicide application made after disease symptoms appear is called curative, it's important to remember that fungicides don't actually bring dead plants back to life. If a lawn or field is suffering from a disease, a curative fungicide application can stop the dead patches from getting bigger. But for the turf to recover takes either good growing conditions for the grass to fill back in if it can spread vegetatively, or to re-establish via new seed if it can't spread vegetatively. This is why turf managers should be much more aggressive about treating (and preventing!) diseases at the end of the growing season: it is much harder to repair damage then than during good growing weather.

Some fungicides are able to be absorbed into plant tissue and moved in a plant's vascular system, while others are not. In general, fungicides that do not move inside a plant are called contact fungicides. These fungicides work by coating the leaf with a protective fungicide barrier that will prevent any spore or piece of fungal mycelium that lands on a leaf from growing and being able to infect the plant. Since contact fungicides can only protect plant parts that the spray lands on, they are useless for treating root diseases like spring dead spot, summer patch, *Pythium* root rot or anything else that infects below ground.

◀ **BERMUDAGRASS** football field with spring dead spot.

Because the contact fungicides work outside the plant, they must coat the entire leaf on both sides. Getting even spray coverage can be tricky in turfgrass, which has many small leaves that overlap each other. This is why fungicide labels specify using large volumes of water, often as much as 5 gallons per 1000 square feet (more than 217 gallons per acre)! This is much more water than is used for spraying herbicides, but it is needed to ensure there is enough fungicide solution to cover every leaf thoroughly. One problem that turf managers often have is that they have only one sprayer and setting it up for both herbicide and fungicide applications can be time consuming. The time it takes to refill a sprayer tank also has to be taken into consideration when deciding on spray volumes for fungicide applications over large areas, like multiple field sports complexes, but the large volumes are on the label for a reason.

Nozzle design also can have a large impact on the effectiveness of fungicide applications. In general, nozzles that produce many smaller droplets or droplets that are designed to shatter into many tiny droplets on impact (flat fan or air induction type nozzles) give better results than raindrop type nozzles designed to produce fewer, large droplets. However, smaller droplets also drift much more easily. Air induction nozzles may offer the best combination of reduced drift and good coverage.

Some fungicides can be absorbed into a leaf and diffuse around different parts of a single leaf, but they do not enter a plant's vascular system and so cannot be transported from leaf to leaf. These are called local penetrant fungicides. Local penetrants, by entering a leaf and diffusing through it, reduce the need for absolutely perfect spray coverage although they are not able to move down from a plant's leaves to the roots and so are, like the true contact fungicides, not effective against root diseases.

With both true contacts and local penetrants, the recommended re-application intervals are relatively short, on the order of 5 days to 2 weeks depending on the individual product and disease pressure. New grass leaves that formed since the last application are not protected, and the fungicide coating can be susceptible to being washed off the leaves or degraded by sunlight. The tradeoff for a relatively short window of protection is that contact fungicides usually are the cheapest.

A fungicide that is able to move throughout an entire plant is called systemic. Systemic fungicides are generally very useful in preventive applications, because they are able to be absorbed by and remain present in a plant for several weeks. Re-application

intervals for these types of fungicides are generally in the two to four week range. However, most systemic fungicides can only move upwards in a plant. If they are absorbed by the roots they will be moved to leaves, and they will move from lower leaves to newer leaves, but they will not move from leaves down to roots. The only exceptions to this rule are the phosphite fungicides.

Because these fungicides are actively taken up by plants, they can be effective against root diseases—provided that there are actually roots there to absorb the fungicide! The problem with root diseases is that above-ground symptoms often don't appear until the root system is almost totally destroyed. In some cases, such as spring dead spot, symptoms don't appear until months after the initial infection. It is much, much better to use a preventive application than a curative application to fight root diseases in almost every case.

It is very difficult to predict where a root disease will occur without complete and accurate records. With most root diseases, the fungus stays in the soil year after year and disease occurs in the same areas over and over again when the weather is favorable for the fungus. So keeping good records of a disease occurrence will allow the proper preventive applications to be made before the next outbreak. When making fungicide applications to prevent a root disease, remember that the fungicide has to move down through the canopy, through the thatch and into the soil before a root can absorb it. Many times a preventive fungicide application will fail because it wasn't sprayed in enough water to wash it thorough the canopy (or it wasn't irrigated in after application), or because the fungicide became bound to organic matter in an excessively thick thatch layer. Again, following label directions for spray volume and irrigation and managing the thatch layer are critical factors in using fungicides successfully against root diseases.

Mode of action refers to the specific biochemical processes in a fungus that a fungicide interferes with in order to kill it, or at least stop it from growing. There are many different modes of action available in the fungicides labeled for use on turfgrass. Some fungicides interrupt a fungus' cell division, some interfere with cell wall or cell membrane synthesis, some disrupt a fungus' ability to make DNA, RNA, or proteins, some stop energy production, and some have more than one mode of action.

One mode of action relatively new to the turfgrass market is the activation of plant defense responses. Chemicals that do this are not toxic to fungi, but they "fool" plants into activating their array of physical and biochemical responses to infection before they are exposed to a fungus. This in turn boosts the plant's ability to resist infection and reduces disease incidence and severity. As noted above, however, this only works if the defense response activator is applied before any infection takes place. This type of fungicide does not work as a curative application.

While there are many different modes of action available, many of the most popular fungicide products for turf contain ingredients with the same mode of action. This brings up the potential problem of fungicide resistance. Fungi are highly diverse and repeatedly spraying the same mode of action selects for any resistant individuals that happen to be present in a given population. If they are, then they multiply while susceptible ones are killed and soon the majority of the fungal population is resistant and the fungicide stops working to prevent disease.

Modern fungicides tend to have very specific sites of action in fungi. For example, many target just one enzyme in a fungus, binding to it and making it no longer able to function. This is good, since it means that the fungicides are very specific and less likely to cause harm to non-target organisms. But it is also bad from a resistance standpoint because it means that all that has to happen for a fungus to become resistant is a small change in that one enzyme such that the fungicide can no longer inactivate it. This happens in nature and often just one or two mutations are enough to make a fungus resistant.

Because of the potential for many turfgrass diseases to become resistant to fungicides, managers have been advised for years to rotate modes of action or to tank mix more than one mode of action at a time in a given application. The international Fungicide Resistance Action Committee (FRAC, www.frac.info) maintains a listing of currently registered fungicide active ingredients and their modes of action. They are sorted into groups of individual ingredients sharing the same mode of action and each group is assigned a unique code.

Recently, manufacturers have begun placing the FRAC mode of action group codes on their product labels. This is a tremendous help to the turf manager trying to manage resistance as now it is immediately obvious which products contain ingredients that have the same mode of action. Now it is possible to tell at a glance whether rotating to a given product will actually mean switching modes of action.

It is important to remember, though, that even though resistance has been documented in many turfgrass diseases, not every failed fungicide application is due to resistance. It is still more common to see fungicides fail due to improper calibration, reading labels incorrectly, not using enough spray volume and/or the wrong nozzles, and plain old misdiagnosis of the disease. Nevertheless, if you suspect resistance, it is a good idea to contact your local Extension agent or plant pathology lab. They will be able to assist you in identifying possible problems with your fungicide application and, if needed, can collect samples and screen them for resistance. ■

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