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PLANT DISEASES

Focusing on Fungicide Resistance

Although the "window of opportunity" for fungicide applications is now closed for some diseases, it remains wide open for others. It's important to continually evaluate how well your fungicide applications perform, but it's equally important to take the time to understand how you can help keep them performing well.

There are many reasons why a fungicide might fail to control disease development. Often, fungicides "fail" because they are applied too early, too late, or not frequently enough. However, for those times when you know you have done everything right yet the performance is less than stellar, consider that you may be dealing with a fungicide-resistant pathogen population. In the world of turf and ornamentals, most documented fungicide resistance problems occur in turf. However, don't be deceived; fungicide resistance can develop in pathogens of trees, shrubs, and flowering plants as well.

Let's step back and address a general question about pesticide-resistant pests: Where do they come from? Genetic diversity through mutations allows resistant pests to be present at extremely low numbers in particular species. When a pesticide effectively controls the majority of susceptible members of a species, only those that possess a resistance trait can survive and reproduce for future generations. In addition, since different pests have various ways to move from one place to another (via airborne spores, seeds, insect vectors, and so on), resistance traits can also be "imported." It is important to remember that resistant populations (sometimes called biotypes, or strains) start out in extremely small numbers. It may take years for you to even notice resistant populations; you may only perceive the problem as shorter-than-expected duration of fungicide protection.

Resistance Terminology

The terms regarding fungicide resistance can be confusing. Following are the key terms you should become familiar with.

FRAC: Fungicide Resistance Action Committee, an international, industry-based committee that issues guidance and anti-resistance strategies for different fungicide groups. FRAC organized the existing fungicide active ingredients into target site groups and gave each group a specific code number. For example, FRAC group 3 includes the well-known DMI fungicides. FRAC code numbers are beginning to appear on some fungicide labels, which will help pest managers in resistance management planning.

Resistance: A change in the pathogen that results in decreased sensitivity to a fungicide. Because the term "resistance" often has a negative connotation or may be confused with host-plant resistance, plant pathologists sometimes refer to "insensitivity" or "tolerance" instead of resistance. However, some experts argue that "insensitivity" should be reserved for describing a fungus that is not inherently controlled by a fungicide (e.g., DMI fungicides never did control pythium or phytophthora; the pathogens did not change). Whatever term is used, be cautious when interpreting reports of fungicide resistance. Just because a pathogen population is deemed resistant to a fungicide, it does not necessarily mean it will completely fail to control the pathogen. As with host-plant resistance, there are degrees of fungicide resistance.

Cross-resistance: Where pathogens are resistant to different fungicides, especially within the same FRAC group. For example, you would suspect cross-resistance if you switched from propiconazole to myclobutanil and did not control your DMI-resistant pathogen population. Both of these fungicides are DMIs and belong to FRAC group 3.

Multiple resistance: The resistance of pathogens to fungicides from different FRAC groups. For example, you would suspect multiple resistance if you treated the previously mentioned DMI-resistant population with azoxystrobin (a FRAC group 11 fungicide) and found that you still could not control the disease.

Resistance Management Strategy

The development of a fungicide-resistant pathogen population can be summarized by the following principle that applies to all pests and pesticides: The appearance of pesticide-resistant pests is the consequence of using the same (or similar) site of action year after year, or of repeating applications of a pesticide during the growing season to kill a specific pest species not controlled by any other pesticides or in any other manner. Specific recommendations for reducing the potential for fungicide resistance development include these:

1. Integrate the use of fungicides into an overall disease and pest management program that includes appropriate cultural practices, host-plant resistance, and scouting.
2. Apply fungicides preventively (when conditions or predictive models suggest disease is likely to occur) rather than curatively, and always use an effective dose.
3. Avoid using an active ingredient (or members of the same FRAC group; see Table 1) more than once per season. For example, there are many different DMI fungicides, but they all have the same site of action. Thus, exclusive use of different active ingredients *within* the same FRAC group is a poor rotation strategy that will promote development of resistant pathogens. If multiple applications are necessary, alternate or tank-mix effective active ingredients from different FRAC groups.
4. Monitor the efficacy of all fungicides used, and record other factors that may influence fungicide performance and/or disease development.

Is It Really Resistance?

How do you know if you are truly dealing with a fungicide-resistant pathogen population? Several criteria may be used to diagnose the problem correctly:

Table 1. FRAC groupings, relative resistance risk, and in-plant mobility descriptions for common turf and ornamental fungicide active ingredients.

FRAC code and group name	Relative resistance risk	Common name	In-plant mobility
1. Methyl benzimidazole carbamates	High	thiophanate-methyl	Systemic (upward)
		thiabendazole	Systemic (upward)
2. Dicarboximides	Medium to high	iprodione	Local penetrant
		vinclozolin	Local penetrant
3. De-methylation inhibitors (DMI)	Medium	fenarimol	Systemic (upward)
		myclobutanil	Systemic (upward)
		propiconazole	Systemic (upward)
		triadimefon	Systemic (upward)
		triforine	Local penetrant
4. Phenyl amides (PA)	High	metalaxyl	Systemic (upward)
		mefenoxam	Systemic (upward)
7. Carboxamides	Medium	boscalid	Systemic (upward)
		flutolanil	Systemic (upward)
11. Quinone outside inhibitors (QoI)	High	azoxystrobin	Systemic (upward)
		kresoxim-methyl	Local penetrant
		pyraclostrobin	Local penetrant
		trifloxystrobin	Local penetrant
12. Phenyl pyrroles (PP)	Low to medium	fludioxonil	Contact-protective
14. Aromatic hydrocarbons (AH)	Low to medium	etridiazole	Contact-protective
		chloroneb	Contact-protective
		quintozene (PCNB)	Contact-protective
17. Hydroxyanilides	Low to medium	fenhexamid	Local penetrant
19. Polyoxins	Medium	polyoxin	Local penetrant
28. Carbamates	Low to medium	propamocarb-hydrochloride	Systemic (upward)
33. Phosphonates	Low (assumed)	fosetyl-Al	Systemic
		phosphorus acid	Systemic
M1. Multi-site inhibitors	Low	copper	Contact-protective
M2. Multi-site inhibitors	Low	sulfur	Contact-protective
M3. Multi-site inhibitors	Low	mancozeb	Contact-protective
		thiram	
M4. Multi-site inhibitors	Low	captan	Contact-protective
M5. Multi-site inhibitors	Low	chlorothalonil	Contact-protective

- The disease was controlled effectively with this fungicide in the past.
- All other causes of fungicide failure have been eliminated (timing, frequency, environmental, or misapplication problems and so on).
- Other diseases on the fungicide label (besides the one in question) were controlled effectively.
- The site has a history of continuous use of the same fungicide or other fungicides within the same FRAC group.

If you answer yes to several or all of these criteria, you should suspect resistance; report it to the fungicide manufacturer representative and to your local University of Illinois Extension office (http://web.extension.uiuc.edu/cie2/offices/findoffice.cfm).

By understanding the fungicides you use and executing a sound fungicide resistance management plan, you can greatly reduce the chances that fungicide-resistant pathogen populations will become a problem. (*Bruce Paulsrud*)

Sources

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2. Brent, Keith, J. “Fungicide Resistance in Crop Pathogens: How can it be managed?” Fungicide Resistance Action Committee. April 1995. <http://www.frac.info/publications.html>. Accessed July 15, 2004.
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INSECTS

Grub Scouting Watch

Japanese beetle adults have emerged throughout the state. They were reported in Will County on June 22. They should be present in damaging numbers until about mid-August. Carbaryl (Sevin), cyfluthrin (Tempo), and other labeled pyrethroids should give about 2 weeks of control, so three treatments will be needed for control on plants that are treated.

Masked chafer adults emerged during the last week of June in central Illinois. Their numbers appear to be relatively small. These are both the southern masked chafer and northern masked chafer, whose larvae are annual white grubs. Both species are 1/2-inch-long, tan June beetles with black heads. They are strongly attracted to lights at night, particularly from about 10:30 to 11:30 p.m. They are present until mid-July. Observe numbers of adult Japanese beetle and masked chafers to determine the need for grub applications. Also observe the state of non-irrigated turf. If non-irrigated turf is green and actively growing through mid-July, the beetles will lay their eggs in both it and watered turf. Unless the adult flight is very large, this will result in low grub numbers as a result of adults’ being spread out. Some areas of Illinois have received enough rainfall for non-irrigated turf to still be attractive for egg-laying. However, a week or two of hot, dry weather can quickly turn lush green turf dry, brown, and dormant. In these situations, the beetles will lay most of their eggs in irrigated turf, resulting in grub injury this fall in those areas.

If high grub numbers are anticipated, application of imidacloprid (Merit) or halofenozide (Mach 2) is warranted during July. Both insecticides take about 3 weeks to kill the grubs, so they need to be applied before early August to avoid grub damage in late August. Another option is to wait until early August when the grubs have hatched. At that time, the grubs can be scouted, and trichlorfon (Dylox) or insecticidal nematodes can be applied to high-population areas. Scout for grubs by cutting through the turf with a heavy knife, then pulling it up to expose the grubs in the root zone. In drier soil, the grubs may be 3 to 6 inches deep, but they will be near the surface if the soil is moist.

This is when first-generation black turfgrass ataenius grubs are full-grown and can cause the most damage. Be watchful for wilting and brown turf in the dampest areas of golf courses. These will be greens and tees as well as locations where water tends to stand or run to after irrigation, such as along the lower side of green aprons and in fairway swales. Fifty or more grubs per square foot is the damage threshold. The grubs will be in the root zone and will look like other grubs, white and C-shaped, but they will be only about 1/4 inch long when fully grown. It is very hard to kill mature grubs with insecticides. *Heterorhabditis bacteriophora*, an insecticidal nematode, should be effective, but it provides only about 60% control. This level usually reduces the impact of the grubs on turf enough for the turf to recover. Commonly the best way to cope with mature grubs is to irrigate to get the grass to grow roots quicker than the grubs can eat them. As the grubs pupate, their feeding on turf roots will lessen, and the turf should improve. (*Phil Nixon*)

Billbugs

Bluegrass billbugs have been reported as numerous in Will County in northeastern Illinois. Billbug populations grow at this time of year, so scouting is beneficial. Bluegrass billbug occurs throughout the state, with hunting billbug being present in southern Illinois on zoysia and bermudagrass.

Billbug larvae are white, stocky, legless larvae that feed on the roots of turf. Fully grown ones are about 1/2 inch long. Damaged turf will be brown, and typically the damage appears in a circular or ovate pattern, with nearby turf unaffected. If tugged, individual stems or grass plants pull out easily. The bases of these will have been raggedly chewed off. Sawdust-like frass from the grubs will be seen on and in the thatch.

Adult billbugs are cylindrical, 3/8-inch-long, hard-shelled, blackish beetles with elongated snouts like elephants. These beetles are generally flightless, so they have to walk everywhere. This lack of long-distance movement usually confines damaged areas somewhat. Because adults are very long-lived, they may be found at any time of year, walking through the grass or along the edge of sidewalks; grubs in all sizes also are found throughout the year. The adult has a tiny mandible (jaw) at the end of the "snout" that it uses to chew a hole in the stem of a grass plant. It then turns around and lays an egg in that hole.

The resulting larva tunnels down through the stem of the grass plant and continues through the rhizome until it gets too big to fit inside the stem. It then emerges into the soil to feed on the grass roots, as do other white grubs. Although larvae can be found at any time of the year in all sizes, they are most numerous at this time of year, making it an ideal time to apply controls. The damage threshold for billbugs is similar to that for grubs. Expect damage at 10 or more per square foot.

Control is the same as for other grubs. Trichlorfon (Dylox) provides control within 3 days, whereas imidacloprid (Merid) and halofenozide (Mach 2) take 3 weeks. Insecticidal nematodes, particularly *Heterorhabditis bacteriophora*, also provide control. Insecticidal nematodes typically provide about 60% control, whereas chemical insecticides should provide about 95% control. (*Phil Nixon*)

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