

## Improving Disease Control

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**Bottom line: The recent commercial introduction of several new fungicide active ingredients (azoxystrobin, flutolanil, myclobutanil, propiconazole) has added several important tools to an already impressive arsenal of disease control products. Nevertheless, disease control is still a very complicated process in which choosing the correct fungicide is only the first step. More subtle factors, such as the timing, placement and coverage achieved with the fungicide can make the difference between success and failure. Thus, the formulation type used (granule or spray), the volume of water used in application, or the use of post-treatment irrigation can play critical role in the development of improved disease control programs.**

**Q. With the introduction of so many new, effective systemic fungicides, how do contact fungicide products now fit into disease management?**

A. Despite the many advantages offered by systemic fungicides, contact fungicides have some unique characteristics that are important in management of above-ground, foliar diseases such as anthracnose, dollar spot, brown patch and algae. This is particularly true when you are trying to protect older, stressed or senescing plants from disease attack. Because these plants are not actively growing, they will take up little or no systemic fungicide. But coating the outside of these plants with contact fungicides can effectively halt fungal growth.

**Q. Are systemic fungicides active only inside the plant, or do they have contact activity as well?**

A. Calling fungicides “systemic” is a bit misleading for a few reasons. First, most “systemic” fungicides have both types of activity – contact (outside the plant) and systemic (inside the plant). Secondly, with the exception of fosetyl-al, thiophanate-methyl, metalaxyl and mefenoxam, most systemic fungicides do not distribute throughout the plant. Instead, they move relatively small distances, and always (with the exception of fosetyl-al) in an upwards direction. Products such as trifloxystrobin, flutolanil, iprodione, propamocarb and vinclozolin move little or not at all once they are absorbed into the plant. Others, such as triadimefon, propiconazole and fenarimol move moderate distances once they are absorbed.

**Q. Are there performance differences between granular and liquid formulations?**

A. Yes. Although there are some exceptions, we find that liquid formulations generally out-perform granular formulations of the same fungicide. Uniformity of coverage is usually better with liquids because the small size and closely spaced droplet patterns help insure that the fungicide will more effectively coat the foliage or cover the soil. The relatively larger size of granules results in gaps between deposits of the fungicide, thus allowing

some areas to “escape” from contact with the fungicide. A second problem sometimes encountered with granules is that the fungicide active ingredient isn’t fully dissolved or “released” by the granule quickly enough. As illustrated in the photo below, when turf is mowed, the granules are removed, thus reducing the rate of product delivered to the turf.



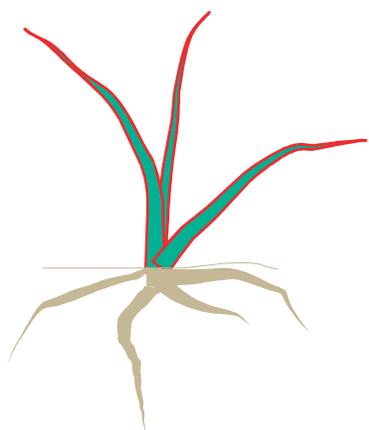
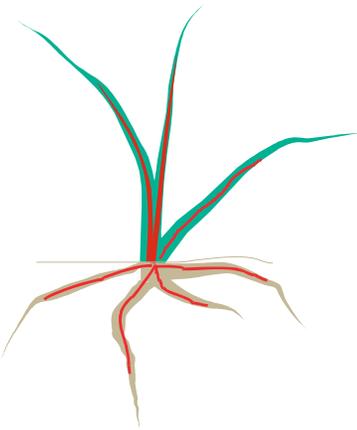
**Q. How important is application volume in the performance of fungicides?**

A. Disease control can be significantly reduced if either too little or too much water is used in fungicide applications. In general, more water — **3 to 4 gallons of water per 1000 sq ft. delivered through flat fan or rain drop nozzles** — is needed when root diseases such as summer patch or take all patch are the targets (see Table 2 for a list of other root and soil borne diseases). The extra water helps wash the fungicide down past the thatch to the roots, where it can act directly on the pathogen, and where the roots can absorb it. If too little water is used in application, some of the fungicide will not reach its target, and will instead remain on the foliage, the soil surface or on the thatch, where it does little good.

In contrast, when foliar diseases such as dollar spot or brown patch are the targets, application volumes of **1-2 gallons per 1000 square feet delivered through flat fan nozzles** are plenty to get the product where it belongs – on the leaves of the plant. If too much water is used, the product will be washed off of the foliage and into the soil, thus reducing efficacy.

**Table 1. Commonly used contact and systemic fungicides**

Active ingredient	Trade names
<b>CONTACT FUNGICIDES</b>	
<ul style="list-style-type: none"> <li>• Work by coating the outside of the foliage with a fungicidal protective shield</li> <li>• Protects older, senescing plants from foliar disease</li> <li>• Not effective on root diseases</li> <li>• Activity reduced by mowing, water, weather</li> </ul>	
chlorothalonil	Concorde, Daconil, Echo, Manicure, Spectro, Thalonil
etrizazole	Koban, Terrazole
mancozeb	Dithane, Fore, Mancozeb, Protect, Pentathlon
PCNB (quintozene)	Defend, Engage, Penstar, Revere, Terraclor, Turfcide
thiram	Thiram, Spotrete
<b>SYSTEMIC FUNGICIDES</b>	
<ul style="list-style-type: none"> <li>• Effective on foliar and root diseases, but must be watered in if root diseases are the target</li> <li>• Absorbed by plant and distributed <b>inside</b> the plant via the vascular system</li> <li>• Because they act internally, systemics are less prone to break-down by water, weather, mowing</li> </ul>	
azoxystrobin	Heritage
fenarimol	Patchwork, Rubigan
flutolanil	Prostar
<b>fosetyl-aluminum*</b>	<b>Aliette, Prodigy*</b>
iprodione	Chipco 26019, Chipco 26GT, Fungicide X
mefonoxam	Subdue Maxx, Quell
metalaxyl	Pythium Control, Subdue
myclobutanil	Eagle, Golden Eagle
propiconazole	Banner Maxx
propamocarb	Banol
thiophanate-methyl	Cavalier, Cleary's 3336, Fungo, Systemic Fungicide
triadimefon	Accost, Bayleton, Fungicide VII, Granular Turf Fungicide
trifloxystrobin	Compass
vinclozolin	Curalan, Touche, Vorlan

**NOTE: fosetyl-aluminum is the only product listed which can move up and down within the plant. All other systemic fungicides move only up.**

**Q. If I have both a foliar and root diseases, what application volume should I use?**

A. Ideally, you should make separate fungicide applications – one high volume application to deal with the root disease, and a separate low volume application to deal with the foliar disease. If you are applying the same fungicide to treat both diseases, then you will need to decide which disease needs the most immediate attention, and determine your application volume accordingly. If necessary, you would then follow up with a second application a few days later, at a different application volume, if the lesser disease is still active.

**Q. Can post-treatment irrigation make a difference in fungicide performance?**

A. Once again, it's all a matter of whether you are targeting a root disease, or a foliar disease. For root diseases, post-treatment irrigation of approximately 1/10 inch, immediately after application, can help move more fungicide towards the roots, without washing the fungicide too far below the roots. If you don't have access to equipment that permits application of 3 – 4 gallons per 1000 square feet, then post-treatment irrigation can help make up this deficit in the treatment of root diseases. Conversely, post-treatment irrigation should be avoided — at least until sprays

have dried on the foliage — when fungicides are applied for control of foliar diseases. The one exception to this rule occurs if you are using a granular formulation. Most manufacturers

recommend that granules be lightly irrigated, even when foliar diseases are the targets, so that the fungicide active ingredient can be released from the granule.

**Table 2. For the purpose of developing management strategies, turf diseases can be divided into two groups: those attacking the foliage (leaves, stems and crowns) or those attacking the roots. Different control strategies apply to each, as illustrated below.**

	Scientific name	Site of attack	
Algae	<i>Oscillatoria</i> , others	<b>FOLIAR:</b> leaves stems and crowns <ul style="list-style-type: none"> <li>• Use 2 gallons of water/1000 sq ft to deliver fungicides</li> <li>• Avoid post-treatment irrigation until after sprays have dried on foliage</li> </ul>	
Anthraxnose (crown & foliar)	<i>Colletotrichum graminicola</i>		
Brown patch	<i>Rhizoctonia solani</i>		
Dollar spot	<i>Sclerotinia homeocarpa</i>		
Gray leaf spot	<i>Pyricularia grisea</i>		
Leaf and crown blight/melting out	<i>Curvularia</i> , <i>Dreschlera</i> , <i>Bipolaris</i>		
Pink snow mold (Fusarium patch)	<i>Microdochium nivalis</i>		
Pythium foliar blight	<i>Pythium</i> spp.		
Red thread	<i>Laetisaria fuciformis</i>		
Southern or Sclerotium blight	<i>Sclerotium rolfsii</i>		
Typhula blight (gray snow mold)	<i>Typhula</i> spp.		
Yellow patch	<i>Rhizoctonia cerealis</i>		
Yellow tuft (downy mildew)	<i>Sclerophthora macrospora</i>		
Necrotic ring spot	<i>Leptosphaeria korrae</i>	<b>ROOTS/SOIL</b> <ul style="list-style-type: none"> <li>• Use 3 – 4 gallons water/1000 sq ft</li> <li>• Post-treatment irrigation (1/10") immediately after treatment</li> </ul>	
Bermudagrass decline	<i>Gaeumannomyces graminis</i>		
Fairy ring	Variety of mushroom forming fungi		
Spring dead spot of bermudagrass	<i>Leptosphaeria</i> , <i>G. graminis</i> , <i>Ophiosphaerella herpotricha</i>		
Summer patch	<i>Magnaporthe poae</i>		
Pythium root rot	<i>Pythium</i> spp.		
Take all patch	<i>G. graminis</i>		

**Q. Are there fungicides that should be avoided during hot weather?**

A. Yes. Fungicides in the sterol inhibitor group can cause some damage to cool and warm season turf when they are applied during hot weather (air temperatures above 85°F). The typical symptoms of sterol inhibitor damage — thinning, yellowed or browning, slow growing turf — are caused by the ability of these products to not only kill fungi, but also to regulate the growth of plants. Although heat related sterol inhibitor damage is usually reversible, you should be wary of using sterol inhibitors such as propiconazole (Banner), fenarimol (Rubigan) and triadimefon (Bayleton) when it is hot. One partial exception to this rule is the sterol inhibitor fungicide myclobutanil (Eagle), which does not appear to cause damage to cool season turf, even when applied at temperatures well above 85°F. However, on warm season turf, myclobutanil may cause heat related damage similar to that caused by other sterol inhibitors (Elliott, 1995).

**Q. Turf diseases caused by the fungus *Gaeumannomyces* (warm season turfgrass decline and take-all patch of bentgrass) seem to be on the rise. In addition to fungicide applications, are there any other steps that can be taken to avoid this disease?**

A. Soil nutrition may help in the management of *Gaeumannomyces* diseases. In a recent publication by Hill et. al. (1999), the authors reported that increased levels of manganese (Mn) can significantly reduce *Gaeumannomyces* incidence. In this two year study conducted in New Jersey, plots treated with manganese (1.8 lbs Mn/acre applied monthly) showed an average of 5% *Gaeumannomyces* infection, while plots receiving no manganese at all had a high level — 20% — of disease. An in-between level of disease (12.5%) resulted when a half rate of manganese (0.9 lbs/acre applied monthly) was applied.

To test the hypothesis that increased manganese can help suppress *Gaeumannomyces* infections, we analyzed the soils of four turf samples that had

been diagnosed by PACE Consulting to have *Gaeumannomyces*. We found that the trend reported by Hill et. al. was confirmed in three out of four samples. In other words, the majority of our diseased samples indeed had lower manganese levels (and lower copper levels as well) than samples from healthy greens and fairways.

Although our results support Hill's findings, results still aren't conclusive. However, there is good

reason to believe that the soil manganese and copper levels that are usually recommended (see "Desired Range" in Table 3) can be significantly increased. Our data suggests that levels of at least 35 ppm (for manganese) and 2.4 ppm (for copper), although even higher than the levels recommended by Hill, may be necessary to help reduce *Gaeumannomyces* incidence.

**Table 3.** Soil nutrient guidelines for management of *Gaeumannomyces*. The values in the "Desired" column represent conventional recommendations. However, when California and Illinois values from good performing turf (from soil survey data maintained by PACE) are compared to the lower values present for diseased turf, it appears that higher levels of manganese and copper may provide beneficial results. NOTE: The range of values presented represents the 95% confidence intervals; ppm = parts per million = mg/kg.

	Desired Range	PACE California data: good performing turf		PACE Illinois data: good performing turf		PACE data from diseased turf
	Greens & Fairways	Greens	Fairways	Greens	Fairways	
Manganese (ppm)	8 - 35	33.1-38.7	32.1-40.4	27.1-43.5	39.1-87.1	12.0
Copper (ppm)	0.6 - 2.0	2.1-2.7	2.8-3.5	3.1-6.1	4.3-6.0	1.4
# of samples tested		330	147	24	25	3

**Table 4. Fungicide active ingredients and the diseases they control.** Contact fungicides are represented in green print; systemic fungicides are in red print.

	azoxystrobin	chlorothalonil	etridiazole	fenarimol	flutolanil	fosetyl-al	iprodione	mancozeb	mefenoxam	myclobutanil	PCNB	propamocarb	propiconazole	thiophanate-methyl	thiram	triadimefon	trifloxystrobin	vinclozolin
Algae																		
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Southern or Sclerotium blight																		
Spring dead spot																		
Summer patch																		
Take all patch																		
Typhula blight (gray snow mold)																		

## References

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