IPM programs for summer disease management on cool-season greens

by Wendy Gelernter, Ph.D. and Larry J. Stowell, Ph.D.

Bottom line: Once average air temperatures exceed 65F (18C), most of turf's key diseases are kicked into gear. For this reason, disease management programs should also be initiated at this time. To minimize disease-related damage while at the same time avoiding unnecessary pesticide applications, we have designed an IPM program that relies on these concepts: 1) integration of a broad palette of products and practices; 2) a preventive approach; 3) initiation when the forecasted threat temperature reaches 65F (18C); 4) rotation of products to avoid disease resistance to fungicides and 5) keeping the turf healthy through sound cultural management. Most importantly, effective programs are all site-specific and take into account the weather conditions, history and specific group of diseases that attack each location.

In this *PACE Insights,* we present IPM summer disease programs for poa and bentgrass greens that strive to minimize disease-related damage while at the same time avoiding unnecessary pesticide applications. Our approach is based on these assumptions:

- keeping the turf healthy is the best defense
- prevention is critical when it comes to diseases of cool-season greens
- programs should be based on site-specific conditions including weather and history of disease occurrence
- integration of a broad palette of products and practices is necessary for sustainable control
- products tend to be most effective when applied at lower rates and more frequently (as opposed to higher rates and less frequently)
- rotation of products among different fungicide resistance management groups is important for preserving efficacy and for avoiding excessive use of pesticides.

Background information on the concepts summarized below can be found on the PACE website (www.paceturf.org). See the "Background Information" section at the end of this publication.

IPM SUMMER DISEASE PROGRAMS FOR BENTGRASS AND POA GREENS

Please note that the programs below are designed to target all major key diseases, and therefore must be streamlined (as described below) to target only those diseases that are present at your location. Programs should be conducted in conjunction with the cultural practices programs outlined on pages 3- 4 and should be initiated in week 1, **when the threat temperature on your PACE Weather Update reaches 65 F**. Programs should be terminated at the end of the summer disease season, or when the threat temperature decreases back down to 65 F. See the section on application volume below for an explanation of "High" vs."Low" volumes of application.

Table 1. IPM disease program for bentgrass greens. Use in conjunction with Table 2 and cultural practices outlined on pp. 3-4.

			WEEK																					
Product	**Volume**	**oz/1000sq ft**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Sterol Inhibitor	High	1/2 Max rate	■				■								■				■					
QoI	High	Max rate			■				■															
Wetting agent	High	Full rate			■				■															
Benzimidazole	High	Max rate									■													
Phosphites	High	Max rate					■				■				■				■				■	
Chlorothalonil	Low	1/2 Max rate		■		■		■		■		■		■		■		■		■		■		■

Table 2. Disease management products for bentgrass greens. See also cultural practices outlined on pp. 3-4

Product	Examples	Primary target	Secondary targets
Sterol inhibitors	Banner, Bayleton, Eagle	Dollar spot	Brown patch, Microdochium Southern blight, Take-all patch
QoI	Heritage, Insignia	Fairy ring	Take-all patch
Wetting agent	Aqueduct, Brilliance, Cascade, HydroWet, Primer, TriCure	Fairy ring	Localized dry spot
Benzimidazole	Cleary's 3336, Fungo Flo, Cavalier	Take-all patch	Brown patch, dollar spot
Phosphites, phosphonates	Aliette Signature, Alude, Magellan, Prodigy, Vital	Pythium	Summer stress management
Chlorothalonil	Daconil, Manicure, Echo	Moss, algae	Dollar spot, algae, brown patch, Microdochium

Why prevention?

When temperatures are warm, diseases move fast. During the late spring, when greens are already stressed by high temperatures and increased traffic, it is usually the case that by the time you spot the symptoms of a disease, it is almost too late to stop it from causing significant damage. While some of the more minor diseases can be controlled curatively, if you have a history with any of the "biggies" — anthracnose, summer patch, Pythium, dollar spot, take-all patch, fairy ring or rapid blight — you know that they are best managed preventively, before symptoms occur. In our experience, a well-designed preventive program will reduce the number of fungicide applications that you make each year, and will result in higher quality turf.

Table 3. IPM disease program for poa greens WITHOUT rapid blight. Use in conjunction with Table 5 and cultural practices outlined on pp. 3-4.

			WEEK																											
Product	**Volume**	**oz/1000sq ft**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Sterol Inhibitor	High	1/2 Max rate	■		■		■		■		■											■		■							■
Heritage	High	1/2 Max rate											■		■			■		■											
Benzimidazole	High	Max rate															■														
Pythium mgt	High	Max rate							■								■					■									
Chlorothalonil	Low	1/2 Max rate						■		■		■		■		■			■		■		■			■		■			

Table 4. IPM disease program for poa greens WITH rapid blight. Use in conjunction with Table 5 and cultural practices outlined on pp. 3-4.

			WEEK																											
Product	**Volume**	**oz/1000sq ft**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**
Sterol Inhibitor	High	1/2 Max rate	■		■		■		■		■											■		■							■
Insignia	High	1/2 Max rate											■		■			■		■											
Benzimidazole	High	Max rate															■														
Pythium mgt	High	Max rate							■								■					■									
Chlorothalonil	Low	1/2 Max rate	■			■				■				■				■			■					■					
Mancozeb	Low	1/2 Max rate		■				■				■				■			■					■				■			

Table 5. Disease management products for poa greens. See also cultural practices outlined on pp. 3-4

Product	Examples	Primary target	Secondary targets
Sterol inhibitors	Banner, Eagle	Anthracnose, summer patch	Rhizoctonia, dollar spot, Microdochium, Southern blight
Heritage	Heritage	Summer patch, fairy ring, take-all patch	Anthracnose (where resistance hasn't occurred), Fusarium patch (pink snow mold), southern blight, brown patch
Insignia	Insignia	Rapid blight, summer patch, fairy ring, take-all patch	Anthracnose (where resistance hasn't occurred), Fusarium patch (pink snow mold), southern blight, brown patch
Benzimidazole	Cleary's 3336, Fungo Flo, Cavalier, Systemic Fungicide	Summer patch resistance management	Rhizoctonia, dollar spot, Fusarium patch (pink snow mold)
Pythium mgt	Subdue Maxx, Aliette Signature, Prodigy	Pythium	—
Chlorothalonil	Daconil, Manicure, Echo	Anthracnose	Algae, moss, Rhizoctonia, dollar spot, Fusarium patch (pink snow mold)
Compass	Compass	Rapid blight	Rhizoctonia, Fusarium patch (pink snow mold))
Mancozeb	Fore, Dithane, Mancozeb, Protect, Pentathlon	Rapid blight	Algae, dollar spot, brown patch, Fusarium patch (pink snow mold), pythium

When to start (and when to stop)

In the old days, before we knew very much about the biology of turf diseases, most management programs were calendar-based — starting and ending on the same dates every year. In some years, these programs worked well, but in years that were either cooler or warmer than average, they failed. Calendar-based programs were also not transferable — if a superintendent changed jobs and moved to a new golf course, the different climate at the new location frequently made their old calendar-driven programs obsolete, and they were forced to start from the ground up once again.

Things are better today, now that we have some basic understanding of the conditions that trigger disease epidemics. This allows us to develop disease programs that are based on the pest's biology and on current weather conditions rather

than on a calendar. These programs are more likely to be effective year in and year out, even when weather patterns change — even when locations change.

The programs above are based on the fact that the key summertime diseases are all triggered when **threat temperatures** reach 65F or higher (for an explanation of the threat temperature concept, see the PACE Update entitled "Improve pest management using threat temperatures" on the PACE website.)

To determine whether the threat temperature at your location has reached 65F yet, check your **Weather Update** on the Member's page of the PACE website. When the forecasted threat temperature reached 65F, your summer disease program should be initiated.

The program should be terminated at the end of the summer disease season, or when the threat temperature on your PACE Weather Update decreases to less than 65 F. In cooler environments, programs will probably run for fewer weeks than illustrated above. In warmer locations, the program may need to run the full number of weeks illustrated.

Streamline the program to fit your needs

The programs above were designed to target all of the major summer diseases of either poa or bentgrass — in other words, the worst case scenario. Luckily, only a few locations suffer with the full spectrum of worst-case diseases. For this reason, you will need to customize and slim down the programs in Tables 1, 3 or 4 to target the specific diseases that you deal with. The following resources will help you in this task.

Review the list of disease "primary targets" and "secondary targets" in **Tables 2 and 5**. Draw a line through any of the diseases that are not serious enough at your location to warrant a preventive application. Does this allow you to eliminate any of the materials in the "Products" column? Does your spectrum of diseases call for substitution of different products than those in Tables 1 - 5? Consult **Table 6** to see if there are other products that would be more effective at covering the specific mix of diseases that you deal with. Finally, **Table 7** allows you to review your product selections with two other factors in mind. The column labeled "Signal word" helps determine whether your program is leaning towards a "least toxics" approach (or away from it!). Products that have been assigned the "Caution" designation by EPA have the lowest short-term toxic effects.

Once you have made any alterations to the program, look at **Table 7** to ensure that the line-up of products that you have selected uses rotation among different resistance management groups. The goal is to avoid more than two sequential applications from products in the same fungicide resistance group — especially if the products are classified as having a high risk of resistance in the "Comments" column.

Cultural practices: without them, you're toast

Nitrogen management: Keep soil nitrogen levels at 3 to 20 ppm, but to avoid turf damage, **do not exceed 20 ppm nitrogen**. It's a good idea to get your soils tested in the spring so that you know what your baseline nitrogen levels are before the summer starts galloping away. Bentgrass greens usually require less nitrogen, and are therefore at the lower end of the 3 to 20 ppm range. To deliver nitrogen in a way that the plants can take it up quickly and efficiently, weekly applications of a complete foliar fertilizer at 0.1 to 0.2 lb nitrogen/1000 square feet is a good option. Remember — 0.5 lb nitrogen/1000 sq ft will produce roughly a 10 ppm increase in soil nitrogen levels.

PACE guidelines for plant available nitrogen in soil

- **Nitrate (NO_3) 3 — 20 ppm**
- **Ammonium (NH_4) less than 7ppm**
- **Total plant available nitrogen less than 20ppm**
- **Nitrate to ammonium ratio greater than 3:1**

DMIs and growth regulators when it's hot: When air temperatures are above 90F, cool-season turf slows down significantly and therefore recovers slowly. For this reason, application of products that slow down turf growth should be handled with care. DMI fungicides such as Banner, Bayleton and Eagle should be avoided during really hot periods, and Primo rates should be adjusted down based on your desired yield of clippings.

Traffic management: Change pin placements and avoid traffic in areas that show stress. Route traffic onto the green at multiple locations. Rope off areas that exhibit excessive wear. Keep the traffic moving by regularly updating traffic flow and pin placements to prevent excessive wear.

Venting: Schedule a monthly "venting" using small diameter hollow cores or solid tines (1/4 inch). Always check soil salt levels and leach to remove excess salts prior to venting. Remember — venting or aeration should be used as a preventive strategy, and not as a remedial tool that is used after damage has occurred.

Raise mowing heights: Raising mowing heights can have a dramatic effect on turf health, weed invasion and the turf's recovery potential. Even an increase of 1/100 inch can make a noticeable difference. Rolling greens up to three times a week can help to keep greens speeds up even as mowing heights rise.

Avoid the buildup of soil salts: Keep soil salinity levels at 3.0 dS/m (equivalent to a reading of approximately 0.7 on the TDS-4 meter) or lower. Monitor soil salinity regularly with a TDS-4 meter, and leach when soil salts reach 3.0 dS/m. For more

information on monitoring soil salinity, see PACE Reference 9:3 "Monitoring soil salinity"

Manage heat and drought: Monitor turf canopy temperatures and be prepared to trigger cooling activities (syringing, fans) when threshold canopy temperatures of 100F (for poa) or 105F (for bentgrass) are reached (see PACE Reference 9:5). If you are not able to monitor canopy temperatures, air temperatures of 90F can be used as a much rougher trigger point. Make sure that irrigation distribution is optimized so that turf does not suffer from drought due to poor distribution (see "Issues in irrigation: The uniformity myth" PACE Insights 6:6).

A combination of heat (several days >100F) and drought due to poor irrigation distribution selectively damaged poa plants on this bent/poa green.

Maximizing fungicide efficacy

Rates and timing: Fungicides used at the high label rates and sprayed every four weeks may be convenient, but it's sometimes not the most effective way to prevent disease. Instead, when products are used at the half of the labeled high rate (for the disease or diseases you are targeting) and applied every two weeks, efficacy is usually improved.

Why is this? If the amount of product used in either scenario is the same, why is one strategy more effective than the other? We believe that turf growth is the major factor here. This is because turf can create a lot of new tissue as it grows over a four week period, and any of the new tissue that forms after the fungicide application will be either untreated (in the case of contact fungicides) or diluted out by the newer, larger plant (in the case of systemics). In contrast, the lower dose/higher application frequency strategy is depositing smaller amounts of fungicide, but is always targeting the newer, unprotected plant tissue, thus providing better protection.

Low vs. high application volume (see Tables 1, 3, 4, 6)**:** Disease control can be significantly reduced if either too little or too much water is used in fungicide applications. In general, more water — **two or more 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. 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. If you are not able to apply two gallons/1000 sq ft or more for control of root diseases, then the product should be watered in immediately after application.

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.

Nozzles: Spray nozzle type can play a large role in the effectiveness of fungicides — especially when contact fungicides are used to control the foliar pests in Table 6. For these pests, flat fan nozzles usually provide the best results because of their ability to provide good spray coverage on the foliage

Why are contact fungicides and foliar pests of particular importance with regards to nozzle type? There are three answers to this question. Firstly, there is coverage. And then there is 2) coverage. And finally, 3) coverage. In trying to defeat pests that attack foliage, we mostly rely on pesticides that work when they come into contact with the pest. It is therefore critical that the leaf surface is evenly coated with the fungicide, so that the contact between pest and pesticide is maximized. Otherwise, these pests are good at finding the blank spots on the foliage and attacking there.

In contrast, coverage is less important for control of root diseases that are controlled by systemic fungicides. This is because with systemic fungicides, the plant assists us in evenly distributing the pesticide within the plant.

Background information on www.paceturf.org

The following background documents can be found on the PACE Member's Edition website by searching for **PACE Insights 11:2**

1. "Monitoring Soil Salinity" PACE Reference 9:3.
2. "Summer Stress Management for 2003" (PACE Insights Volume 9, Number 5)
3. "Cultural practices for alleviating summer stress". (PACE Reference 9:5)
4. "Improve pest management using threat temperatures" (PACE Update 4/12/04).
5. "Issues in irrigation: the uniformity myth (PACE Insights 6:6)".

Table 6. Selected Fungicide Active Ingredients and the Diseases That They Control Most Effectively

Based upon observations and research from around the country.

		azoxystrobin	boscalid	captan	chlorothalonil	etridiazole	fenarimol	fludioxonil	flutolanil	fosetyl-Al	iprodione	mancozeb	mefenoxam	metalaxyl	myclobutanil	PCNB	phosphonates	polyoxin D zinc	propamocarb	propiconazole	pyraclostrobin	thiophanate-methyl	thiram	triadimefon	trifloxystrobin	vinclozolin
Target Roots (2+gal/1000 sq ft or light syringe)	Fairy ring, other basidiomycetes *Agrocybe, Bovista*																									
	Necrotic ring spot *Ophiosphaerella*																									
	Root rot *Pythium*																									
	Spring dead spot *Ophiosphaerella*																									
	Summer patch *Magnaporthe*																									
	Take-all patch and decline *Gaeumannomyces*																									
Target Foliage (for best results apply in 1-2 gal/1000 sq ft)	Algae *Oscillatoria,* cyanobacteria																									
	Anthracnose *Colletotrichum*	R																			R	R			R	
	Bentgrass dead spot *Ophiosphaerella*																									
	Blight and leaf spot *Curvularia, Bipolaris*																									
	Brown/yellow patch *Rhizoctonia*																									
	Dollar spot *Lanzia*																									
	Pink snow mold/fusarium patch *Microdochium*																									
	Gray leaf spot *Pyricularia*	R																			R				R	
	Gray snow mold *Typhula*																									
	Blight *Pythium*																									
	Rapid blight *Labyrinthula*																									
	Red thread Laetisaria																									
	Southern blight *Sclerotium*																									

some systemicity: xylem, phloem or localized

Contact

R Resistance management is critical - use with caution

Always refer to the product label to confirm all use, handling, and application details.

Table 7. Key Fungicide Active Ingredients, Trade Names, Signal Words and Fungicide Resistance Groups

Fungicides are organized into Fungicide Resistance Groups based on mode of action and chemical structure. Current resistance management strategies rely on rotation among different fungicide resistance groups. Source: Fungicide Resistance Action Committee (**www.frac.info**) Signal words are designated by the EPA to describe the short term toxicity of a formulated pesticide product and appear on all pesticide product labels. They progress from **CAUTION** (least toxic) to **WARNING** to **DANGER** (most toxic). Toxicity may be due to the active ingredient and/or the inert formulation ingredients. For this reason, some active ingredients listed below have multiple signal words, depending on the specific formulated product.

Active Ingredient	Signal Word	Trade names	Fungicide Resistance Group	Group #	Comments
thiophanate-methyl	Caution	Cavalier, Cleary's 3336, Fungo, Systemic Fungicide	MBC (methyl benzimidazole carbamates)	1	High Risk: Resistance common; includes dollar spot & anthracnose
iprodione	Caution	Chipco 26019, Chipco 26GT, Fungicide X	dicarboximides	2	Medium Risk: Resistance known in dollar spot
vinclozolin	Caution	Curalan, Touche, Vorlan	dicarboximides	2	
fenarimol	Caution	Patchwork, Rubigan	DMI (demethylation inhibitor)s	3	Medium Risk: Resistance known in some fungal species, including dollar spot
myclobutanil	Caution	Eagle, Golden Eagle	DMI	3	
propiconazole	Warning	Banner Maxx	DMI	3	
triadimefon	Caution	Accost, Bayleton, Fungicide VII, Granular Turf Fungicide	DMI	3	
mefonoxam	Caution	Subdue Maxx, Quell	Phenylamides	4	High Risk: Pythium resistance known
metalaxyl	Caution	Pythium Control, Subdue	Phenylamides	4	
boscalid	Warning	Emerald	Carboxamides	7	Medium Risk: No known resistance in turf diseases
flutolanil	Caution	Prostar	Carboxamides	7	
azoxystrobin	Caution	Heritage	QoI: includes strobilurins	11	High Risk. Resistance known in gray leaf spot and anthracnose
pyraclostrobin	Caution	Insignia	QoI	11	
trifloxystrobin	Caution	Compass	QoI	11	
fludioxonil	Caution	Medallion	Phenylpyrrole	12	Medium Risk
etridiazole	Warning	Koban, Terrazole	Aromatic hydrocarbons	14	Medium Risk: Resistance known, but none on turf diseases
PCNB (quintozene)	Caution	Defend, Engage, Penstar, Revere, Terraclor, Turfcide	Aromatic hydrocarbons	14	
polyoxin D zinc	Caution	Endorse	Polyoxins	19	Medium Risk: None reported in turf
propamocarb	Caution	Banol	Carbamate fungicides	28	Medium Risk: None reported in turf
fosetyl-Al	Caution	Aliette	Phosphonates	33	Low Risk: Resistance known, but none on turf diseases
phosphonates	Caution	Prodigy, Alude, Magellan, ReSyst	Phosphonates	33	
mancozeb	Caution	Dithane, Fore, Mancozeb, Protect, Pentathlon	Multi-site activity	M	Low Risk: no signs of resistance developing
thiram	Caution	Thiram, Spotrete	Multi-site activity	M	
chlorothalonil	Warning or Danger	Concorde, Daconil, Echo, Manicure, Thalonil	Multi-site activity	M	
captan	Danger	Captan	Multi-site activity	M	