



IPM

Planning Guide

reference

Disease Reference

Presented by the



**Environmental
Institute for Golf**

The philanthropic organization of **GCSAA** 

DISEASE REFERENCE

Anthracnose, *Colletotrichum cereale*

DAMAGE CAUSED

Symptoms of damage:

Foliage: older leaves attacked first. Leaves may appear water-soaked and/or display small, reddish-tan leaf spots or elongate yellow leaf spots. As the disease advances, foliage will turn brown and black, hair-like fungal structures known as acervuli (photo to right) may develop.

Crown or basal rot: lower leaf sheaths and crowns become dark-colored, leaves turn yellow-orange, and acervuli (photo to right) are common.

Overall appearance: small, irregular patches of yellowing, thinning or brown turf eventually grow larger if the infestation is not controlled.



Plants attacked:

Poa annua is the most common target.

Other hosts include (in order of frequency observed) bentgrass, Kentucky bluegrass, bermudagrass.

Pests/conditions that cause similar damage

rapid blight

black turfgrass ataeenius

high soil salts (salinity)

heat or drought stress

Predictive models

Spring and summertime, once average air temperatures reach 65F (18C).

Conducive environmental conditions:

Average air temperatures greater than 65 F(18C)

Anything that stresses turf, such as:

High soil salts (salinity)

Low fertility

Compaction

Traffic

Heat or drought

Excessive shade

Poor drainage

DISEASE REFERENCE

Low mowing heights

Geographic distribution:

Worldwide

MONITORING TECHNIQUES:

Monitor air temperatures. When average air temperatures reach 65F (18C), begin scouting turf for early symptoms.

Focus scouting efforts on weak or stressed areas, or areas where the disease has occurred in the past. This is where symptoms are likely to occur earliest.

THRESHOLDS:

For golf courses where anthracnose has been a problem in the past, preventive control is warranted (see Management Strategies below).

For situations where a curative approach is used, control should be implemented as soon as symptoms are seen.

DISEASE REFERENCE

MANAGEMENT STRATEGIES:

Strains of anthracnose resistant to QoI (strobilurin) and benzimidazole fungicides have been documented in several locations. These products are noted with a red asterisk (*). Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Fungicide Resistance Management Groups." Always consult the most recent version of all product labels before use.

TYPE	TIMING	PRACTICE	
Cultural	N/A	<ul style="list-style-type: none"> Adequate nitrogen (0.1 – 0.2 lb nitrogen/wk during season), but do not exceed 20 ppm total nitrogen in soil Maintain soil salinity below 3.0 dS/m for cool season turf Apply Primo Maxx at 1/8 oz/1000 sq ft every 14 days during anthracnose threat period. Schedule a monthly "venting" using small diameter (1/4") hollow cores or solid tines. Raise mowing heights as much as possible. 	
Biological	Preventive: apply when average air temperatures reach 65F (18C)	Polyoxin-D (Endorse) ¹	
Chemical	Preventive: apply when average air temperatures reach 65F (18C)	Active Ingredient (Product)	Label signal word
		Azoxystrobin (Heritage)**	Caution
		Chlorothalonil (Daconil Weatherstik) + fludioxinil (Medallion)*	Caution/Caution
		Chlorothalonil (Daconil Weatherstik) + fosetyl-AI (Chipco Signature)	Caution/Caution
		Chlorothalonil (Daconil Weatherstik) + polyoxin D (Endorse) ¹	Caution/Caution
		Fosetyl-AI (Chipco Signature) + iprodione (Chipco 26GT)	Caution/Caution
		Myclobutanil (Eagle)	Caution
		Propiconazole (Banner)	Warning
		Pyraclostrobin (Insignia)*	Caution
		Thiophanate-methyl (Cleary's 3336)*	Caution
		Trifloxystrobin (Compass)**	Caution
	Curative : less desirable strategy, with less than optimal results in most cases	Chlorothalonil (Daconil Weatherstik) + fludioxinil (Medallion)*	Caution/Caution
		Chlorothalonil (Daconil Weatherstik) + fosetyl-AI (Chipco Signature)	Caution/Caution
		Chlorothalonil (Daconil Weatherstik) + polyoxin D (Endorse) ¹	Caution/Caution
		Chlorothalonil (Daconil Weatherstik) + propiconazole (Banner Maxx)	Caution/Warning

* considered reduced risk by the U.S. Environmental Protection Agency.

* has been ineffective in some locations due to development of resistance.

¹ Designated as a biopesticide by the U.S. Environmental Protection Agency

DISEASE REFERENCE

Fairy ring

Lycoperdon spp., *Marasmius oreades*, *Bovista plumbea*, *Agrocybe pediades* and many other fungi in the family Basidiomycetes

DAMAGE CAUSED

Symptoms of damage:

Type 1: rings of dead grass with outer zone of dark green stimulated turf; basidiocarps (mushrooms or puffballs) may be produced

Type 2: ring of dark green stimulated turf; basidiocarps may be produced

Type 3: rings of basidiocarps with no apparent effect on turf growth

Plants attacked:

All turf types and cultural conditions.

Pests/conditions that cause similar damage

Brown patch

Brown ring patch

PREDICTING DISEASE

Threat temperature:

When average air temperature for five consecutive days exceeds 60 F (16C)

Conducive environmental conditions:

Drought

MONITORING TECHNIQUES:

In spring, once threat temperatures (>60F or 16C) are reached, monitor for dark green rings, localized dry spot in a ring pattern or mushrooms/puffballs in a ring pattern.

THRESHOLDS:

Curative: Monitor for first signs of rings; make curative applications once rings are detected

Preventive: If there is a history of fairy ring, make preventive applications of fungicides and wettings agents in spring, once threat temperature is reached.

Type 1 symptoms



Type 2 symptoms



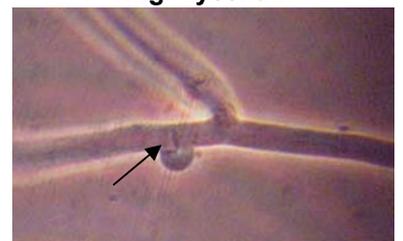
Type 3 symptoms



Thatch degraded by fairy ring fungi



Clamp connection on fairy ring mycelium



DISEASE REFERENCE

MANAGEMENT STRATEGIES:

The products below have demonstrated good activity in research field trials on fairy ring. Follow resistance management guidelines by rotating products as outlined in IPM Template Reference “Fungicide Resistance Management Groups.” Always consult the most recent version of all product labels before use.

TYPE OF CONTROL	PRACTICE	
Cultural	<ul style="list-style-type: none"> • Adequate nitrogen (0.1 – 0.2 lb nitrogen / 1000 ft² / wk [0.5 – 1.0 g nitrogen/ m² / wk] during season), but do not exceed 20 ppm total nitrogen in soil • Utilize wetting agents to prevent dry spots from developing 	
Biological	polyoxin D zinc (Endorse) ¹	
<p>Chemical Curative: Apply as soon as rings or dry patches begin to appear. Treat all areas with a history of disease.</p> <p>Chemical Preventive: If a history of fairy ring is present, preventive application may be needed when average air temperature for 5 consecutive days exceed 60 F (16 C)</p>	Active Ingredient (Product)	Signal word
	azoxystrobin (Heritage) ²	Caution
	Triadimefon (Bayleton 50 WP)	Caution
	polyoxin D zinc (Endorse) ¹	Caution
	flutolanil (Prostar 70WP)	Caution
	pyraclostrobin (Insignia)	Caution

¹ Designated as a biopesticide by the U.S. Environmental Protection Agency

² Designated “reduced risk” by the U.S. Environmental Protection Agency

DISEASE REFERENCE

Gray leaf spot, *Pyricularia grisea*

DAMAGE CAUSED

Symptoms of damage:

Foliar disease

Early symptoms include water-soaked lesions on foliage that eventually enlarge, turning grey or brown. A yellow “halo” may form around the lesions

The tips of infected leaves eventually darken, wither and twist before dying.

Production of fungal conidia on foliage produces a gray, velvety or felt-like appearance

Dying plants form large (6 – 12 inches or 15 – 30 cm in diameter), irregular shaped patches of discolored turf that eventually coalesce into larger patches



Plants attacked:

Ryegrass

Fescue

St. Augustinegrass

Kikuyugrass

Pests/conditions that cause similar damage

Pythium blight

Predictive models

Optimum conditions when Maximum daily temperature + minimum daily relative humidity ≥ 140 .

Conducive environmental conditions:

Average air temperatures >68 F

Presence of free water on leaf surface

High relative humidities

Geographic distribution:

All U.S. states with the exception of the upper mid-West and Pacific Northwest

MONITORING TECHNIQUES:

Begin scouting once average air temperatures reach 68 F (20 C). Target the most susceptible areas of the course (high mown perennial ryegrass, areas that are shady or have low air movement).

DISEASE REFERENCE

If there is a history of the disease, preventive fungicide applications once the temperature (F) /humidity index of 140 is reached (maximum temperature, F plus minimum relative humidity)

MANAGEMENT STRATEGIES:

Strains of gray leaf spot resistant to Qol (strobilurin) fungicides have been documented in several locations. These products are noted with a red asterisk (*) Follow resistance management guidelines by rotating products as outlined in IPM Template Reference “Fungicide Resistance Management Groups.” Always consult the most recent version of all product labels before use.

TYPE	TIMING/ THRESHOLD	PRACTICE	
Cultural	N/A	<ul style="list-style-type: none"> • Use tolerant varieties of ryegrass or resistant turf varieties (bermuda, bluegrass, bentgrass) • Be moderate with nitrogen fertility (less than 20 ppm soil nitrogen) • Avoid sand topdressing and aerification during GLS threat period • Improve drainage and irrigation to avoid wet areas • Avoid springtime applications of ethofumesate 	
Biological			
Chemical	Preventive: apply when maximum temperature (F) plus minimum relative humidity = 140	Active ingredient	Label signal word
		Azoxystrobin (Heritage) * *	Caution
		Propiconazole (Banner) plus chlorothalonil (Daconil Weatherstik)	Warning/Caution
	OR Early curative	Pyraclostrobin (Insignia) *	Caution
		Thiophanate-methyl (Cleary's 3336)	Caution
		Triadimefon (Bayleton) plus chlorothalonil (Daconil Weatherstik)	Caution/Caution
Trifloxystrobin (Compass) * *	Caution		

* considered reduced risk by the U.S. Environmental Protection Agency.

* has been ineffective in some locations due to development of resistance.

DISEASE REFERENCE

Rapid blight, *Labyrinthula terrestris*

DAMAGE CAUSED

Symptoms of damage:

Small, irregular shaped patches of diseased turf that develop rapidly

Foliage turns yellow to brown with a water-soaked appearance

No mycelium is formed

Plants attacked:

Poa annua

Poa trivialis

Ryegrass

Bentgrass (to a lesser extent)

Pests/conditions that cause similar damage

Anthracnose

Drought stress

Dollar spot

Necrotic ring spot

Snow mold

Summer patch

Predictive models

Occurs as long as weather is conducive for turf growth (average air temperatures >55F or 13 C)

Conducive environmental conditions:

Soil sodium > 110 ppm (Mehlich III extraction)

> 2dS/m soil salinity

Average air temperatures > 55 F (13 C)

Use of high salinity irrigation water

Geographic distribution:

Southern U.S., United Kingdom

MONITORING TECHNIQUES:

Begin monitoring for early symptoms when average air temperatures reach 55 F (13 C)



DISEASE REFERENCE

MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Fungicide Resistance Management Groups." Always consult the most recent version of all product labels before use.

TYPE	TIMING/ THRESHOLD	PRACTICE	
Cultural	N/A	Keep soil sodium levels < 110 ppm (Mehlich III) and soil salinity levels < 2dS/m. Monitor for soil salinity. If disease is active, avoid cultural practices that physically injure turf such as aerification, sand topdressing or renovation.	
Biological			
Chemical	Preventive or early curative	Active ingredient	Label signal word
		mancozeb (Fore)	Caution
		pyraclostrobin (Insignia)	Caution
		trifloxystrobin (Compass) *	Caution

* considered reduced risk by the U.S. Environmental Protection Agency.

DISEASE REFERENCE

Rhizoctonia complex: brown patch, yellow patch, sheath spot and brown ring patch

Rhizoctonia solani (brown patch), *R. cerealis* (yellow patch), *R. zeae* and *R. oryzae* (sheath spot) or *Waitea circinata* var. *circinata* (brown ring patch).

DAMAGE CAUSED

Symptoms of damage:

Chlorotic (yellow) or necrotic (dying) rings or solid patches of various sizes.

Sometimes green rings form after fungicide application

Plants attacked:

All turf types and cultural conditions.

Pests/conditions that cause similar damage

Fairy ring

Pythium blight

Geographic distribution:

Worldwide

PREDICTING DISEASE

Threat temperatures:

Dependent upon species:

Brown patch (*Rhizoctonia solani*) average air temperature 70 – 90 F (21 – 32 C)

Yellow patch (*Rhizoctonia cerealis*) average air temperature 50 – 65 F (10 – 18 C)

Sheath spot (*Rhizoctonia oryzae* and *R. zeae*) average air temperature 80 – 97 F (27 – 36 C) insensitive to thiophanate methyl

Brown ring patch (*Waitea circinata* var. *circinata*) average air temperature 77 – 86 F (25 – 30 C) insensitive to thiophanate methyl

Conducive environmental conditions:

High relative humidity or leaf wetness

Low light levels

High soil nitrogen levels

Brown patch on bermuda



Brown patch on kikuyugrass



Waitea on Poa annua



Waitea mycelium on rye overseeded bermudagrass



Micrograph of Rhizoctonia hypha



DISEASE REFERENCE

MONITORING TECHNIQUES:

Monitor air temperatures and begin scouting for early signs of damage when threat temperatures (see above) are reached

Focus scouting efforts on areas with a known history of disease.

THRESHOLDS:

In most cases, curative application of effective fungicides at the first signs of disease will provide good control.

If there is a history of Rhizoctonia disease, preventive application of fungicides may be needed to prevent serious damage and to reduce fungicide inputs. If the disease becomes established, multiple fungicide applications will be needed.

MANAGEMENT STRATEGIES:

The products below have demonstrated good activity in research field trials on Rhizoctonia diseases. Follow resistance management guidelines by rotating products as outlined in IPM Template Reference “Fungicide Resistance Management Groups.” Always consult the most recent version of all product labels before use.

TYPE OF CONTROL	PRACTICE	
Cultural	<ul style="list-style-type: none"> • Adequate nitrogen (0.1 – 0.2 lb nitrogen / 1000 ft² / wk [0.5 – 1.0 g nitrogen/ m² / wk] during season), but do not exceed 20 ppm total nitrogen in soil • Maintain soil salinity below 3.0 dS/m for cool season turf • Avoid excessive irrigation and leaf wetness during warm conditions. 	
Biological	polyoxin D zinc (Endorse) ¹	
<p>Chemical Curative: Apply as soon as any chlorotic rings appear. Treat all areas with a history of disease.</p> <p>Chemical Preventive: If there is a history of Rhizoctonia disease, preventive application may be needed when threat temperatures are reached</p>	Active Ingredient (Product)	Signal word
	azoxystrobin (Heritage) ²	Caution
	chlorothalonil (Daconil Weatherstik)	Caution
	flutolanil (Prostar 70WP)	Caution
	fludioxonil (Medallion) ²	Caution
	iprodione (Chipco 26019)	Caution
	polyoxin D zinc (Endorse) ¹	Caution
	propiconazole (Banner Maxx)	Warning
	trifloxystrobin (Compass) ²	Caution

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² Designated “reduced risk” by the U.S. Environmental Protection Agency

DISEASE REFERENCE

Yellow spot (algae, cyanobacteria)

Oscillatoria spp, Phormidium spp.

DAMAGE CAUSED

Symptoms of damage:

Initial symptoms are yellow spots that can expand to encompass large areas.

Severe symptoms can result in large declining areas with algal scum at the surface of the thatch

Plants attacked:

Low mown turfgrasses including poa, bentgrass and bermudagrass.

Pests/conditions that cause similar damage

High soil salts (salinity)

Traffic damage

Heat or drought stress

Localized black layer

Geographic distribution:

Worldwide

PREDICTING DISEASE

Threat temperature

Spring and summertime, once average air temperatures exceed 60F (16C) for 5 consecutive days

Conducive environmental conditions:

Shade

Average air temperatures greater than 60 F(16C)

Low mowing height

Use of organic fertilizers

Compaction

Traffic

Poor drainage

Symptoms on A4 bentgrass



Algae on leaf tips after 48 hr incubation in dark



Oscillatoria trichomes under microscope



DISEASE REFERENCE

MONITORING TECHNIQUES:

Monitor air temperatures. When average air temperatures exceed 60F (16C), begin scouting turf for early symptoms.

Focus scouting efforts on shady areas with a history of algae. This is where symptoms are likely to occur earliest.

Collect a cup cutter sample and incubate in a plastic bag (closed) in the dark for 48 hours. Opening the bag will release a musty odor and the leaf tips will be colonized by a dark slimy film of cyanobacteria.

THRESHOLDS:

Curative: Monitor for characteristic small, yellow spots; apply fungicides curatively once spots appear

Preventive: In shady areas with a history of algae, periodic preventive applications of fungicides, made during the spring and summer, may be needed to prevent decline

MANAGEMENT STRATEGIES:

The products below have demonstrated good activity in research field trials on cyanobacteria. Always consult the most recent version of all product labels before use.

TYPE	TIMING	PRACTICE	
Cultural	N/A	<ul style="list-style-type: none"> Adequate nitrogen (0.1 – 0.2 lb nitrogen / 1000 ft² / wk [0.5 – 1.0 g nitrogen/ m² / wk] during season), but do not exceed 20 ppm total nitrogen in soil Maintain soil salinity below 3.0 dS/m for cool season turf Raise mowing heights as much as possible. Avoid use of organic fertilizers Regularly topdress greens with sand 	
Biological	None known		
Chemical	Curative: Apply after a few spots appear on a green. Only treat affected greens. Preventive: Apply once average air temperatures exceed 60F (16C) in areas with history of infestation	Active Ingredient (Product)	Label signal word
		Chlorothalonil (Daconil Weatherstik)	Caution
		Mancozeb (Fore 80WP)	Caution

DISEASE REFERENCE

Fungicide Resistance Management Groups

Fungicides are organized into Fungicide Resistance Groups based on mode of action and chemical structure. In general, a pest that develops resistance to one fungicide within a group will probably be cross-resistant to other members of the group. Therefore, current resistance management strategies rely on rotation among different fungicide resistance groups. Source: Fungicide Resistance Action Committee (www.frac.info)

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

DISEASE REFERENCE

Selected Fungicide Active Ingredients and the Diseases that They Control

Based upon observations and research from around the United States

		azoxystrobin	boscalid	captan	chlorothalonil	etridiazole	fenarimol	fludioxonil	flutolanil	fosetyl-AI	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 <i>Agrocybe, Bovista</i>																									
	Necrotic ring spot <i>Ophiosphaerella</i>																									
	Root rot <i>Pythium</i>																									
	Spring dead spot <i>Ophiosphaerella</i>																									
	Summer patch <i>Magnaporthe</i>																									
	Take-all patch and decline <i>Gaeumannomyces</i>																									

some systemicity: xylem, phloem or localized

Contact

R Resistance management is critical - use with caution

Target Foliage for best results apply in 1-2 gal/1000 sq ft	Algae <i>Oscillatoria, cyanobacteria</i>																									
	Anthracnose <i>Colletotrichum</i>	R																			RR				R	
	Bentgrass dead spot <i>Ophiosphaerella</i>																									
	Blight and leaf spot <i>Curvularia, Bipolaris</i>																									
	Brown/yellow patch <i>Rhizoctonia</i>																									
	Dollar spot <i>Sclerotinia</i>																									
	Pink snow mold/fusarium patch <i>Microdochium</i>																									
	Gray leaf spot <i>Pyricularia</i>	R																				R				R
	Gray snow mold <i>Typhula</i>																									
	Blight <i>Pythium</i>																									
	Rapid blight <i>Labyrinthula</i>																									
	Red thread <i>Laetisaria</i>																									
	Southern blight <i>Sclerotium</i>																									

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