

Guide to Turfgrass Fungicides

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Common Turfgrass Diseases and Chemical Controls

Rhizoctonia complex (Brown Patch and Large Patch). Caused by *Rhizoctonia* spp. (mostly *R. solani* in Georgia). The disease can affect all species of warm- and cool-season turfgrasses, including bentgrass, ryegrass, tall fescue (Brown Patch) and St. Augustinegrass, zoysiagrass, centipede and bermudagrass (Large Patch). The most favorable conditions for disease development usually occur from late April through October. Brown patch is favored by high relative humidity during the day and a minimum temperature of 60 degrees F at night. Excess soil moisture, extended leaf wetness and/or high levels of nitrogen increase severity of the disease. **Symptoms:** Leaf blades or sheaths are blighted in circular patches measuring several inches to feet across. In bermudagrass, centipede and ryegrass, patches are brown. In St. Augustinegrass, patches appear straw-colored. Smoke rings may be present in bentgrass. Mycelium may be evident early in the morning.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval
Chlorothalonil (Concord DF, Concord SST, Count Down, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Echo DF, Manicure, Evade, Prograde 500)	Flowable: Preventive 3 to 6 fl oz at 7-10 days interval; Curative 6-11 fl oz at 7-10 day interval. Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval.
Fenarimol (Rubigan A.S. 11.6)	0.75-1.5 fl oz at 10-21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Fludioxonil (Medallion)	0.5-0.9 fl oz at 14 to 28 day interval.
Flutolanil (Prostar)	Preventive 2.2 oz at 21-28 day interval. Curative 4.5 oz at 30 day interval.
Iprodione (Chipco 26GT, Chipco 26019, Ipridione Pro 2SE)	2-4 oz at 14-21 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Maneb, Maneb + zinc sulfate, Mancozeb (Tersan LSR, Fore, Dithane, Protect T/O,	Preventive 3-4 oz at 7-10 day interval.

etc.)

Myclobutanil (Eagle 40WSP)	0.6 oz at 10-28 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
PCNB (Defend, Engage, Penstar, Revere, Terraclor, Turfcide, Turfgo)	16 oz at 21-28 day interval on warm season grasses. 3-4 oz at 7-10 days interval on cool season grasses with the exception of bentgrass.
Polyoxin D (Endorse)	4 oz at 14 day interval.
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14-21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb at 15-30 day interval. Curative 3 lb at 15-30 day interval Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 day interval.
Thiophanate methyl (Cleary's, 3336, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	2 oz at 7-10 day interval. Not highly effective on diseases caused by <i>Rhizoctonia zeae</i> and <i>R. oryzae</i> .
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-10 day interval.

Dollar Spot. Caused by *Sclerotinia homoeocarpa*. All species of warm- and cool-season turfgrass are susceptible. Tall fescue, Kentucky bluegrass, perennial ryegrass, bentgrass, centipede, zoysiagrass and bermudagrass hybrids are particularly susceptible. The disease is promoted by dry soil conditions, extended leaf wetness and low nitrogen levels in soil. **Symptoms:** Circular straw-colored infection centers are only a few inches across, although spots may merge, resembling brown patch. Live blades may have straw-colored lesions along one edge. Lesion expands across blade, causing tip to dieback. Abundant white fungus growth evident early in the morning when dew is present may be seen during periods of severe disease development.

Buscalid (Emerald)	0.13-0.18 oz at 14-28 day interval.
Chlorothalonil (Concord DF, Concord SST, Count Down, Daconil Ultrex, Daconil	Flowable: Preventive 3 to 6 fl oz at 7-10 days

Weatherstik, Daconil Zn, Echo DF, Manicure, Evade, Prograde 500)	interval; Curative 6-11 fl oz at 7-10 day interval.
Fenarimol (Rubigan A.S. 11.6)	Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval. 0.75-1.5 fl oz at 10-21 day interval Frequent applications at temperatures >85°F may cause adverse growth regulation effect
Fludioxonil (Medallion)	0.5-0.9 fl oz at 14 to 28 day interval.
Iprodione (Chipco 26GT, Chipco 26019, Ipridione Pro 2SE)	2-4 oz at 14-21 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Maneb, Maneb + zinc sulfate, Mancozeb (Tersan LSR, Fore, Dithane, Protect T/O, etc.)	Preventative 3-4 oz at 7-10 day interval.
Myclobutanil (Eagle 40WSP)	0.6 oz at 10-28 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
PCNB (Defend, Engage, Penstar, Revere, Terraclor, Turfcide, Turfgo)	16 oz at 21-28 days interval on warm season grasses. 3-4 oz at 7-10 days interval on cool season grasses except on bentgrass.
Polyoxin D (Endorse)	4 oz at 14 day interval
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14 -21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.9 oz at 14 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb granular at 15-30 day interval. Curative 3 lb granular at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 days.
Thiophanate methyl (Cleary's, 3336, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	2 oz at 7-10 day interval.
Vinclozolin (Vorlan, Curalan, Touche)	Preventive 3 oz at 7-10 day interval.

Pythium Blight. Caused by *Pythium* spp. Annual bluegrass, tall fescue, perennial ryegrass and varieties of bentgrass, bermudagrass, centipede, zoysiagrass and St. Augustinegrass are susceptible. The disease is promoted by excessive soil moisture caused by over irrigation or heavy rain showers. Some *Pythium* species favor

temperatures between 32 degrees F and 50 degrees F while others thrive in temperatures between 70 degrees F and 90 degrees F. **Symptoms:** Small, irregular spots may enlarge and appear dark and water-soaked in early stages. White, cottony mycelia may be evident. Turfgrass in affected spots dies rapidly, collapses, and appears oily and matted. Gray to white fungal growth may be evident early in the morning on leaves of some turfgrass species.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Chloroneb 65 WP (Termec SP, Terraneb, Proturf fungicide)	
Etridiazole (Koban 30WP, Terrazole)	Preventive 3-4 oz at 7-10 day interval.
Fosetyl AL (Alliette 80WP, Chipco Signature, Prodigy Signature)	4-8 oz at 14-28 day interval.
Mefenoxam (Subdue, Subdue Maxx)	Preventive 1 oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb at 15-30 day interval. Curative 3 lb at 15-30 day interval.
Phosphorous acid (Alude)	4.0 oz at 14 day interval.
Phosphonate (Magellan, Vital)	Preventive 4.1-8.2 oz at 14 day interval.
Propamocarb (Banol)	2 oz at 7-10 day interval.
Pyraclostrobin (Insignia)	0.9 oz at 10-14 day interval.
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-10 day interval.

Helminthosporium Leaf Spot. Caused by *Drechslera* spp; *Bipolaris* spp; (formerly *Helminthosporium* spp). Perennial ryegrass, tall fescue and some varieties of bentgrass, bermudagrass, zoysiagrass and centipede are susceptible. The conditions that promote the disease are low potassium levels, extended leaf wetness and/or high nitrogen levels in soil. *Drechslera* is favored by cool wet weather whereas *Bipolaris* is active during warm weather of midsummer. Leaf spot occurs in areas that experience more than 10 hours a day of foliar wetness for several consecutive days. Disease is also favored by high amounts of nitrogen and a low mowing height, and drought stress. **Symptoms:** Small, dark spots or streaks on grass blades and sheaths. Leaf spots are more numerous near the collar area of the leaf blade. Severely affected turfgrass may become brown and thin.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Chlorothalonil (Concord DF, Concord SST,	Flowable: Preventive 3 to 6 fl oz at 7-10 days

Count Down, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Ech DF, Manicure, Evade, Prograde 500)	interval; Curative 6-11 fl oz at 7-10 day interval. Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval.
Fenarimol (Rubigan A.S. 11.6)	0.75-1.5 fl oz at 10-21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Fludioxonil (Medallion)	0.5-0.9 fl oz at 14 to 28 day interval.
Iprodione (Chipco 26GT, Chipco 26019, Ipridione Pro 2SE)	2-4 oz at 14-21 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Maneb, Maneb + zinc sulfate, Mancozeb (Tersan LSR, Fore, Dithane, Protect T/O, etc.)	Preventive 3-4 oz at 7-10 day interval.
Myclobutanil (Eagle 40WSP)	0.6 oz at 10-28 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
PCNB (Defend, Engage, Penstar, Revere, Terraclor, Turfcide, Turfgo)	16 oz at 21-28 days interval on warm season grasses. 3-4 oz at 7-10 days interval on cool season grasses.
Polyoxin D (Endorse)	4 oz at 14 day interval
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14 -21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventative 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb at 15-30 day interval. Curative 3 lb at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 day interval.
Thiophanate methyl (3336 F or WP, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	4-8 oz at 7-14 day interval.
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-14 day interval.

***Curvularia* Diseases.** Caused by *Curvularia spp.* Perennial ryegrass, tall fescue, bentgrass, bermuda-grass, zoysiagrass and centipede are susceptible to the disease. The conditions that promote the disease are similar to *Helminthosporium* leaf spot. Usually weakly pathogenic unless turfgrass is predisposed to high temperature stress. **Symptoms:** Vary with type of grass. Fescue — indefinite yellow/green dappled pattern extending

down from leaf tip. Affected area turns brown, then gray, and then dies. Reddish brown margin may or may not be present. In Bentgrass, affected parts of blades are tan instead of brown or gray.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Chlorothalonil (Concord DF, Concord SST, Count Down, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Ech DF, Manicure, Evade, Prograde 500)	Flowable: Preventive 3 to 6 fl oz at 7-10 days interval; Curative 6-11 fl oz at 7-10 day interval. Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval.
Fenarimol (Rubigan A.S. 11.6)	0.75-1.5 fl oz at 10-21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Fludioxonil (Medallion)	0.5-0.9 fl oz at 14 to 28 day interval.
Iprodione (Chipco 26GT, Chipco 26019, Ipridione Pro 2SE)	2-4 oz at 14-21 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Maneb, Maneb + zinc sulfate, Mancozeb (Tersan LSR, Fore, Dithane, Protect T/O, etc.)	Preventive 3-4 oz at 7-10 day interval
Myclobutanil (Eagle 40WSP)	0.6 oz at 10-28 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
PCNB (Defend, Engage, Penstar, Revere, Terraclor, Turfcide, Turfgo)	16 oz at 21-28 days interval on warm season grasses. 3-4 oz at 7-10 days interval on cool season grasses.
Polyoxin D (Endorse)	4 oz at 14 day interval.
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14 -21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb granular at 15-30 day interval. Curative 3 lb granular at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 day interval.
Thiophanate methyl (Cleary's, 3336, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	2 oz at 7-10 day interval.
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-10 day interval.

Gray Leaf Spot. Caused by *Pyricularia grisea*. Gray leaf spot affects a wide variety of hosts. However it is of primary importance on St. Augustinegrass and perennial ryegrass. Bermuda, centipede, bentgrass and various species of fescue may also be affected, albeit to a lesser degree. Conditions promoting disease include: high humidity, warm temperatures, and high nitrogen levels. **Symptoms:** On St. Augustinegrass, gray leaf spot first appears as small, brown spots on the leaves and stems. The spots quickly enlarge to approximately ¼ inch in length and become bluish-gray in color and oval or elongated in shape. The mature lesions are tan to gray in color and have depressed centers with irregular margins that are purple to brown in color. A yellow border on the lesions can also occur. Severely affected blades wither and turn brown.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Chlorothalonil (Concord DF, Concord SST, Count Down, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Ech DF, Manicure, Evade, Prograde 500)	Flowable: Preventive 3 to 6l fl oz at 7-10 days interval; Curative 6-11 fl oz at 7-10 day interval. Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval.
Polyoxin D (Endorse)	4 oz at 14 day interval.
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14 -21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb granular at 15-30 day interval. Curative 3 lb granular at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 days.
Thiophanate methyl (Cleary's, 3336, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	4-8 oz at 7-14 day interval.
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-10 day interval.

Fairy Ring. Caused by few species of mushroom and puff ball-producing fungi (*Basidiomycetes*). The disease is particularly damaging on centipede and St. Augustinegrass in south and coastal Georgia. The conditions promoting disease are: Presence of fungus and moist, warm weather. **Symptoms:** Circular or semi-circular band of darker-than-usual green grass. Grass inside ring usually is not as vigorous and may be declining. Grass may be dead inside young rings; a band of dead grass with greener grass

in the middle may be seen in older rings. During rainy, moist conditions, a ring of mushrooms may appear.

Azoxystrobin (Heritage 50WG)	0.2 -0.4 oz at 14 to 28 day interval.
Flutolanil	Preventive 2.2 oz at 21-28 day interval. Curative 4.5 oz at 30 day interval.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.

Take-All Patch, Take-All Root Rot, Bermudagrass Decline. Caused by *Gaumannomyces graminis*. Bentgrass, St. Augustinegrass, bermudagrass and centipedegrass are susceptible. Bluegrass and fescues are rarely affected in Georgia. Take-all patch typically occurs in wet soils and in areas with soil pH 6.5 or above. This disease is more severe on less fertile and sandy soils. **Symptoms:** Wilted circular patches that are brown or bronze-colored and measure up to several feet in diameter. Infected plants have dark-brown roots.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Fenarimol (Rubigan A.S. 11.6)	4.0 to 8.0 fl oz at 30 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb at 15-30 day interval. Curative 3 lb at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1-0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 day interval.

Rust. Caused by *Puccinia* spp., *Uromyces* spp. Susceptible turfgrass include Kentucky bluegrass, ryegrass, bentgrass, zoysiagrass, bermudagrass and fescue. Rusts occur in early spring through mid-summer. Rusts favor moist, low-light areas. Depending on the species, rusts favor temperatures between 65 degrees F and 85 degrees F. Severe rust infections occur on slow-growing turfgrass maintained under conditions of low nitrogen and/or drought stress. **Symptoms:** Light-yellow flecks on the leaf blades and sheaths. The flecks enlarge, elongate, and turn yellow in color. The infected areas expand above the epidermis and then rupture, releasing spores that are yellowish-orange to reddish-brown in color.

Azoxystrobin (Heritage 50WG)	0.2 to 0.4 oz at 14 to 28 day interval.
Chlorothalonil (Concord DF, Concord SST, Count Down, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Ech DF, Manicure, Evade, Prograde 500)	Flowable: Preventive 3 to 6 fl oz at 7-10 days interval; Curative 6-11 fl oz at 7-10 day interval. Wettable Powder: Preventive 1.75-3.5 oz at 7-10 day; Curative 3.5-6.5 oz at 7-10 day interval.
Fenarimol (Rubigan A.S. 11.6)	0.75-1.5 fl oz at 10-21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Fludioxonil (Medallion)	0.5-0.9 fl oz at 14 to 28 day interval.
Iprodione (Chipco 26GT, Chipco 26019, Ipridione Pro 2SE)	2-4 oz at 14-21 day interval.
Mancozeb + Copper Hydroxide (Junction)	2-4 oz at 7-14 day interval.
Maneb, Maneb + zinc sulfate, Mancozeb (Tersan LSR, Fore, Dithane, Protect T/O, etc.)	Preventive 3-4 oz at 7-10 day interval.
Myclobutanil (Eagle 40WSP)	0.6 oz at 10-28 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
PCNB (Defend, Engage, Penstar, Revere, Terraclor, Turfcide, Turfgo)	16 oz at 21-28 days interval on warm season grasses. 3-4 oz at 7-10 days interval on cool season grasses.
Polyoxin D (Endorse)	4 oz at 14 day interval.
Propiconazole (Banner Maxx, Banner GL)	1-2 fl oz at 14 -21 day interval. Frequent applications at temperatures >85°F may cause adverse growth regulation effect.
Pyraclostrobin (Insignia)	0.5-0.9 oz at 14-28 day interval.
Triadimefon (Bayleton 25WP, Granular turf fungicide, Systemic fungicide)	Preventive 1 oz at 15-30 day interval. Curative 2 oz at 15-30 day interval. Preventive 1.5 lb granular at 15-30 day interval. Curative 3 lb granular at 15-30 day interval.
Trifloxystrobin (Compass)	Preventive 0.1 -0.2 oz at 14 day interval. Curative 0.15-0.25 oz at 21 day interval.
Thiophanate methyl (Cleary's, 3336, Topsin, Fungo, Absorb TM, Cavalier, Systec 1998)	2 oz at 7-10 day interval.
Thiram 75WP (Tersan 75, Spotrete)	Preventive 3 oz at 7-10 day interval.

Turfgrass Fungicide Formulations

Fungicides are available in many different formulations. Below are the common formulations and their standard abbreviations.

1. Wettable Powders (WP)

Most fungicide are formulated as wettable powders. The active ingredient is normally combined with a solid material (clay or talc) and is suspended in water with the aid of an emulsifier. Many of these suspensions settle out quickly, so an agitator is needed in the spray tank to keep the particles in suspension. Even though plant injury is rarely a problem with wettable powders, there can be excessive wear on spray nozzles with prolonged use of these formulations.

Examples: Bayleton, Prostar, Tersan, Alliette etc.

2. Water Soluble Packets (SP or WSP)

Some WP fungicides are now available in water soluble pouches. These pouches contain enough product for a single application. Pouches are placed in the mixing tank to release the fungicide; this reduces the exposure of mixer and loader personnel to dust from the fungicide. Fungicides available in this form do not require continuous agitation.

Example: Eagle

3. Granules (G)

Small pellets of inert ingredients (normally clay) are sprayed with the desired amount of active ingredient. Generally, granules are large in size (ranging from 40 to 80 mesh). Granules can be applied to turf with a fertilizer spreader or incorporated directly into the soil.

Examples: Compass G; Andersons Bayleton etc.

4. Emulsifiable Concentrates (EC)

A liquid fungicide, insoluble in water, dissolved in an organic solvent. An emulsifying agent is incorporated in the formulation, so when the product is mixed with water, an emulsion is formed. When the product is added to water it forms a “milky” mixture consisting of the active ingredient and the emulsifier. An emulsion is a suspension of very tiny droplets of the solvent/fungicide in water. Once mixed with water in a spray tank, an EC can require some agitation to maintain a suspension.

5. Flowables (F or L)

Flowables are insoluble fungicides ground into very fine particles, usually by a wet grinding process, and impregnated on a carrier such as clay or talc. The active ingredient is mixed with a liquid and an inert ingredient to form a suspension. The liquid is thick

and requires dilution in water before application. Flowables remain suspended in water for relatively long periods of time, but they should be agitated before use. Flowables are dust-free, easy to mix, remain in suspension longer than wettable powders, and may also resist washing off the plant better than wettable powders. They need to be protected from freezing, however.

Example: Lesco Twosome

6. Water Dispersible Granules (WDG) or Dry Flowable (DF)

The two names are interchangeable with one another. These are similar to wettable powders. The active ingredient is prepared as granule-sized particles and must be mixed with water. The small granules can be poured from a container like a liquid. They are virtually dust-free, more readily measured than wettable powders, and disperse easily in water to form a suspension. They require constant agitation and cause some nozzle wear on spray equipment.

Examples: Heritage, Spectro, Systar, Buscalid

7. Fumigants

Fumigants are chemicals that turn into a poisonous gas after application. They are generally used for soil fumigation. Some are formulated only as gases, while others are liquids that turn to gas when injected into the soil. Advantages of fumigants include toxicity to a wide range of pests and effectiveness with a single application. The area treated with fumigants must be enclosed or covered, and special safety and application equipment are needed.

Example: Curfew

Classification of Turfgrass Fungicides

Fungicides may be classified by similarities in their chemical structure, topical activity and mode of action.

Chemical Structure

There are 13 chemically related groups or “chemical families” of fungicides (Table 1).

Fungicides in a common chemical family are similar in their topical activity and mode of action. If a fungus develops resistance to one fungicide in a chemical family, then it is usually resistant to other fungicides in the same family.

Table 1. List of specific chemical families and the common and trade names of those products

within each chemical family.

Chemical Family	Common Name	Trade Name	Type/Mode of Action
Aromatic hydrocarbons	chloroneb	Anderson's Fungicide V 6.25G Anderson's Turf Fungicide 7.5G Termec SP, Terraneb SP Proturf Fungicide V	Protectant fungicide Mode of action: Interferes with mitosis.
	etridiazol (ethazole)	Koban 30WP, Terrazole 35WP	
	PCNB	Anderson's 10-0-14 Fertilizer + 15% PCNB, Anderson's FFII 15 .4G (14-3-3), Cleary's PCNB, Defend 4F, Defend 75WP, Defend 10G, Engage 75W, Engage 10GF, FF II, Lesco Revere 4000 4F, Lesco Revere 10G, Parflo 4F, Penstar 75WP, Penstar 15G, Penstar 4F, Revere 10G, Revere 4000, Flowable Turf, Terraclor 75% WP, Terraclor 75% WP (T&O), Turfcide 400F, Turfcide 10G, Turfgo	
Benzimidazoles	thiophanate methyl	Absorb TM, Anderson's Systemic Fungicide 2.3G, Cavalier, Cleary's 3336 50W/WSP, Cleary's 3336 2G, Cleary's 3336 4.5F, Fungo Flo AGC, Fungo 4.5F, Fungo Flo 50WSB, Lesco T-Storm (50WSP & Flowable), OHP 6672 (4.5L & 50W), Proturf Systemic Fungicide, Scott's Lawn Fungus Control, Systec 1998 85WDG, Topsin	Systemic Mode of action: Fungicide binds tubulin subunits that results in mitotic arrest.
	thiophanate methyl + chloroneb	Anderson's Turf Fungicide IX (1.63% + 3.26%) 4	
	thiophanate methyl + chlorothalonil	9G ConSyst 66WDG, Spectro 90WDG	
	thiophanate methyl +	SysStar WDG (28.58% + 51.42%)	

	flutolanil		
	thiophanate methyl + iprodione	Anderson's Fluid Fungicide (19.65% + 19.65%)	
	thiophanate methyl + mancozeb	Durosan, Zyban	
Carboxamides	flutolanil	Prostar 70WP	Systemic; blocks activity of certain respiratory enzymes.
	boscalid	Emerald 70EG (WDG)	Blocks activity of certain respiratory enzymes.
Demethylation Inhibitors (DMI)	fenarimol	Rubigan A.S., Rubigan E.C.	Systemic
	fenarimol + chlorothalonil	Lesco TwoSome 4F	Mode of action:
	myclobutanil	Anderson's Golden Eagle 0.39G, Eagle 20EW, Eagle 40WP, Eagle WSP	Sterol inhibitor (ergosterol); inhibits cell membrane synthesis.
	myclobutanil + mancozeb	MANhandle (2.25% + 60%)	
	propiconazole	Banner Maxx 1.24 MEC, Banner GL 3.6WSP, Lesco Spectator 3.6EC, Propiconazole Pro 1.3MEC; Quali-pro propiconazole 14.3	
	triadimefon	Accost 1G, Anderson's Fungicide VII 0.59G, Anderson's 1% Bayleton 1G, Bayleton 25WP, Bayleton 50WSP, Lebanon Bayleton 1G, Lesco Granular turf fungicide 1G, Lesco Systemic fungicide contains 50% Bayleton, Pro Bayleton, Proturf Fungicide VII	
	triadimefon + flutolanil	Prostar Plus	
	triadimefon + metalaxyl	Anderson's Fluid Fungicide II (16% triadimefon + 16% metalaxyl)	
	triadimefon +	Fluid Fungicide III F (1.59% +	

	thiram	40.76%)	
Dicarboxamides	iprodione vinclozolin		
Carbamates and Dithiocabamates	mancozeb mancozeb + copper hydroxide	Dithane 4SC Rainshield, Dithane 75DF Rainshield, Dithane DF, Dithane DF Rainshield, Dithane F-45 Rainshield, Dithane M-45, Dithane WF Rainshield, Dithane T/O Rainshield 75WP, Dithane 37WF, Flowable Mancozeb 4, Fore, Fore Flo-XL 4F, Fore 80WP Rainshield, Formex 80W, Lesco Mancozeb 75DG, Lesco 4 Flowable Mancozeb 4F, Mancozeb + Copper, Mancozeb DG, Manzate 80WP, Manhandle, ManKocide, Manzate 75DF, Manzate Flowable Protect T/O Junction 60DF, Junction 61WF	Protectant fungicide Mode of action: Enzyme inactivation
Carbamates and Dithiocabamates (cont.)	Maneb propamocarb hydrochloride propamocarb + chlorothalonil	Maneb Plus Zinc F4, Maneb 75DF, Pentathlon 4F, Pentathlon 75DG Banol Lesco Par 6.25F	Localized penetrant. Mode of action: Alters cell membrane function.
Copper	copper hydroxide	Kocide 2000 TNO, Nu-Cop	Protectant Mode of action: Non-specific breakdown of proteins and enzymes.
Nitriles	chlorothalonil	Anderson's 5% ChloroStar 6F, 82.5WDG, Concord DF, Concord SST 6F, Countdown, Daconil 5G, Daconil Ultrex, Daconil Weatherstik, Daconil Zn, Echo DF, Echo 500,	Protectant fungicide Mode of action: Toxic to cell membrane.

		Manicure, Evade, Prograde 500, 75WDG, Lebanon Daconil 5G, Lesco Manicure T/O, 6F, Thaloniil, Ultrex 82.5WDG	
	chlorothalonil + propiconazole	Echo Propiconazole Turf Fungicide Co-Pack 75WDG + 3.6EC	
Phenylamides	metalaxyl	Subdue 2E, Proturf Pythium Control, Apron (seed treatment)	Systemic Mode of action: Inhibits RNA synthesis.
	mefenoxam	Anderson's Pythium Control 1.2G, Apron XL LS, Mefanoxam 2, Quell, Ridomil Gold EC, Subdue GR, Subdue Maxx, Subdue WSP, Tri-Power Selective	
Phenylpyrrole	fludioxinil	Maxim 4FS, Medallion	Protectant Mode of action: Disrupts amino acid metabolism.
Phosphonates	fosetyl-A1	Aliette 80WP, Aliette WDG, Chipco Signature, Prodigy Signature, Lesco Prodigy Signature 80DG, Monterey Aliette (new homeowner product), Terra Aliette T/O, 80WDG	Systemic fungicide Mode of action: General fungitoxic effect.
	phosphite (salts of phosphorus acid)	Magellan, AGRI-FOS (CA), Fosphite, Reliant	
Strobilurins	azoxystrobin	Heritage, Heritage TL	Systemic. Mode of action: ATP inhibition
	pyraclostrobin	Insignia 20WDG	Localized penetrant. Mode of action: ATP inhibition.
	trifloxystrobin	Compass 50WDG, Compass 50WSP, Compass G	Localized penetrant. Mode of action: ATP inhibition.
	fluoxastrobin	Disarm	Localized penetrant. Mode of action: ATP inhibition.
Antibiotic	Polyoxin D	Endorse	Localized penetrant. Mode of action: Inhibits

chitin production, which is a major component of the cell wall in many fungi; inhibits spore germination.

Hydrogen dioxide	Zerotol	Peroxyacetic acid/ Hydrogen peroxide	Contact fungicide. Biosafe systems.
Potassium bicarbonate	Kaligreen	Potassium bicarbonate	AgBio
Dipotassium Phosphate	Biophos	Phosphate	AgBio

Table adapted and modified from Martinez, A. 2006. Turfgrass Disease: Pest Control Recommendations for Professionals. Cooperative Extension, University of Georgia College of Agricultural and Environmental Sciences.

Table 2. Turfgrass fungicides sold as pre-packed mixtures.*

Active Ingredients	Product Names
copper hydroxide + mancozeb	Junction
fenarimol + chlorothalonil	Lesco Twosome
propiconazole + chlorothalonil	Echo Propiconazole Turf Fungicide
propamocarb + chlorothalonil	Lesco Par
iprodione + thiophanate methyl	26/36 Fungicide, Proturf Fluid Fungicide
metalaxyl + triadimefon	Proturf Fluid Fungicide II
myclobutanil + mancozeb	MANhandle
thiophanate methyl + chloroneb	Proturf Fungicide IX
thiophanate methyl + chlorothalonil	ConSyst, Spectro, Broadside
thiophanate methyl + flutalonil	Systar, Prostar Plus
thiophanate methyl + mancozeb	Duosan
thiophanate methyl + thiram	Bromosan
triadimefon + thiram	Proturf Fluid Fungicide III
triadimefon + flutolanil	Prostar Plus
triadimefon + trifloxystrobin	Armada, Tartan
azoxystrobin + propiconazole	Headway

* Adapted and modified from Vincelli, P., and A.J. Powell. 2006. Chemical Control of Turfgrass Diseases. <http://www.ca.uky.edu/agc/pubs/ppa/ppa1/ppa1.pdf>

Topical Activity

Topical activity refers to the fungicide's activity. According to their site of interaction, fungicides can be divided into two main categories:

Contact: A contact fungicide kills or inhibits the fungus that it comes in contact with. These fungicides can also be applied to leaves, but can only inhibit the growth of the fungus if it is present on the leaf surface. Contact fungicides do not enter the plant.

Systemic: Fungicides that have systemic qualities are absorbed by leaves or roots and transported within the plant to provide fungicidal activity. Some systemics move short distances from the site of application, such as across a leaf blade (local systemic or translaminar). Some fungicides are weakly systemic and can move farther from the application site than local systemics.

Most systemics move more extensively because they are mobile in xylem tissue. When applied to the root zone, these are absorbed by roots and then move upward through the plant with the transpiration stream (xylem-mobile systemic).

Xylem-mobile systemics applied to leaves move throughout the leaf where deposited, but cannot be redistributed out of that leaf; however, any material deposited on stems can move upward into leaves. Phloem-mobile systemics (also known as "true" or amphimobile systemics) have bi-directional mobility; some material moves in phloem out of the leaf where it is deposited upward to other leaves and downward to roots. Systemics cannot move again after translocation.

Mode of Action

Mode of action refers to physiological processes of the fungus that are affected by the fungicide. Fungal processes affected are normally at the cellular level. Fungicidal action can be expressed in one of two visible ways: (1) inhibition of fungal growth and (2) inhibition of spore germination.

Becoming familiar with a fungicide's mode of action is important for resistance management, and for incorporating fungicides with different modes of action into a disease management program.

There are four categories of fungicide mode of action. Each of the four categories are discussed in detail below with examples of chemical families and specific fungicides that fit each category.

Specific examples of each of the fungicides within these categories are included in [Table 1](#).

Electron Transport Chain Inhibition

The specific members of this group inhibit mitochondrial respiration, which blocks the production of energy. Some examples include:

Strobilurins — Members of this family of fungicides are derived from naturally occurring fungicides in edible mushrooms and wood-decaying mushrooms. They provide good control of downy and powdery mildews, leaf spots, rusts and many other turfgrass diseases. Specifically, members in this group contain the active ingredients azoxystrobin, pyraclostrobin, or trifloxystrobin. Specific fungicides that contain strobilurins include Heritage, Compass and Insignia.

Enzyme Inhibition

These fungicides inhibit the action of important fungal enzymes.

Carbamates and Dithiocarbamates — These fungicides are contacts that cause a direct interference with the respiratory processes of the cell and inactivate Sulfhydryl (SH) groups in amino acids, proteins and enzymes. There are several fungicides in this group that are commonly used on turfgrasses to control a broad spectrum of diseases. Specific fungicides in this group include: Dithane, Mancozeb and Manzate.

Carboxamides — The fungicides in this group interfere with respiration of the fungal cells by blocking the activity of certain respiratory enzymes. Flutolanil (Prostar) is a carboximide that is commonly used in turfgrass disease control.

Copper — Fungicides containing copper are the oldest group of fungicides used for disease control. Their use dates back to the 1700s. The majority of these products are either blue, green, red or yellow powders that are insoluble in water. Copper fungicides are contacts that cause a non-specific breakdown of proteins and enzymes and are most effective at controlling leaf spot fungi. Specific examples of fungicides that contain copper include Junction and Kocide.

Aromatic hydrocarbons (substituted aromatics) — These chemicals are diverse in mode of action, but basically they reduce growth rates and sporulation of fungi. Specific fungicides in this family include Terraneb and PCNB.

Phenylpyrrole — The fungicides in this family are systemic in nature, and act by disrupting amino acid metabolism. The majority of the members in this family are insecticides, but some are fungicides. Specific fungicides that include this chemistry are Maxim and Medallion.

Nitriles — There is only one member of this group that is labeled for disease control on turfgrass, chlorothalonil. This fungicide disrupts normal cell metabolism and the regulation of cell functions. Examples include Daconil.

Inhibition of Nucleic Acid Metabolism and Protein Synthesis

Benzimidazoles — The fungicides in this family cause morphological distortion of germinating spores by inhibiting DNA synthesis (nuclear division). These chemistries are not toxic to fungi in their initial form but are broken down into metabolites that are toxic

to fungi. Active ingredients with this specific chemistry used for turfgrass control are limited to thiophanate-methyl. Specific fungicides that contain this active ingredient are Cleary's 3336, Topsin and Cavalier.

Phenylamides — These materials depress nucleic acid synthesis by decreasing the levels of RNA synthesis. The fungicides in this family provide good control of soil-borne diseases caused by omycetes, which include *Phytophthora* and *Pythium*. Active ingredients in the family include mefenoxam, metalaxyl, and oxadixyl. Specific fungicides containing these active ingredients include Subdue MAXX.

Dicarboximides — Inhibit DNA and RNA synthesis, cell division and cellular metabolism. Chemistries in this family are effective at controlling a wide range of pathogenic fungi including *Fusarium*, *Rhizoctonia* and *Sclerotinia*. Active ingredients in this family include iprodione and vinclozolin. Specific products available include Touché, Chipco 26019 and Vorlan.

Sterol Synthesis Inhibition

Ergosterol is the major sterol in most fungi and is essential for membrane structure and function. Ergosterol is the target of fungicides that inhibit sterol synthesis. Examples include:

Demethylation inhibitors (DMI) — This group of fungicides is also referred to as the sterol biosynthesis inhibitors (SBIs). The fungicides in this group work specifically by inhibiting the syn-thesis of ergosterol, which is necessary for the formation of the cell membrane. One of the vital functions of the cell membrane is to protect cell contents from outside chemicals by screening what flows into the cells. There are subgroupings within the DMIs that include the pyrimidines and the triazoles. Active ingredients in the DMI group include fenarimol, myclobutanil, triadimefon and propiconazole. Specific fungicides that are demethylation inhibitors include Rubigan, Eagle, Banner Maxx and Bayleton.

Antibiotics. They specifically interfere with fungal cell wall synthesis by inhibiting chitin synthase. Examples of fungicides that are chitin synthase inhibitors include Endorse.

Multi-Site Activity

Phosphonates — The mode of action of the members of this group is complex and includes both direct and indirect mechanisms. One example is fosetyl-Al, which is registered for control of Pythium blight on turfgrasses. Once fosetyl-Al enters the plant, it degrades to phosphonate (phosphonic acid), which functions as a fungicide. In general the members of this group have direct fungitoxic activity against fungi and enhance the plant's natural defenses. Specific fungicides in this group include Aliette and Prodigy.

Biofungicides

Biofungicides are naturally based microbial or biochemical products. There are two types of biopesticides: (1) Microbial biopesticides with an active ingredient that is a biological control agent (organism capable of attacking or competing with a pathogen or pest), and (2) plant biopesticides or plant-incorporated protectants are “pesticidal substances that plants produce from genetic material that has been added to the plant.”

Table 3. Biofungicides labeled for turfgrass.

Trade Name	Active Ingredient	Company
Ecoguard	Bacillus licheniformis SB 3086	Novozymes
Rhapsody	Bacillus subtilis QST 713	Agraquest

Efficacy of Turfgrass Fungicides

Table 4. Efficacy of turfgrass fungicides and cross reference fungicides/disease controlled.

Disease	Anilides	Aromatic hydrocarbons		Benzamide	Benzimidazole	Carbamate
	boscalid	chloroneb	etridiazole	flutolanil	thiophanate methyl	propamocarb
Algae	----	----	----	----	----	----
Anthracnose	----	----	----	----	XXX	----
Brown Patch	----	X	----	XXXX	XXX	----
Dollar Spot	XXXX	----	----	----	XXXX	----
Fairy Ring	----	----	----	XXX	----	----
Gray Leaf Spot	----	----	----	----	XXXX	----
Large Patch	----	----	----	XXXX	----	----
Leaf Spot/Melting Out	----	----	----	----	----	----
Pythium Blight/Root Rot	----	XX	XXX	----	----	XXXX
Rust	----	----	----	----	X	----
Spring Dead Spot	----	----	----	----	----	----
Summer Patch	----	----	----	----	XX	----
Take All Patch	----	----	----	----	XX	----
Yellow Patch	----	----	----	XXX	----	----

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Disease	Dicarboximides			DMIs		
	iprodione	vinclozolin	fenarimol	myclobutanil	propiconazole	triadimefon
Algae	----	----	----	----	----	----
Anthracoze	----	----	XXX	XXX	XXX	XXX
Brown Patch	XXX	X	X	XX	XX	XX
Dollar Spot	XXX	XXXX	XXXX	XXXX	XXXX	XXXX
Fairy Ring	----	----	----	----	----	----
Gray Leaf Spot	----	----	----	----	XX	----
Large Patch	XX	----	----	XX	XXX	XXXX
Leaf Spot/Melting Out	XXXX	XXXX	----	----	XX	X
Pythium Blight/Root Rot	----	----	----	----	----	----
Rust	----	----	----	----	XXXX	XXXX
Spring Dead Spot	----	----	XXX	X	XX	----
Summer Patch	----	----	XX	XXX	XXX	XXX
Take All Patch	----	----	XXX	----	XX	XXX
Yellow Patch	----	----	----	----	XX	----

Disease	EBDC	Nitrile	Phenylamide	Phenylpyrole
	mancozeb	chlorothalonil	mefenoxam	fludioxonil
Algae	XXXX	XXXX	----	X
Anthracoze	----	XXX	----	----
Brown Patch	XXX	XXX	----	XXX
Dollar Spot	X	XXX	----	----
Fairy Ring	----	----	----	----
Gray Leaf Spot	XX	XX	----	----
Large Patch	----	----	----	----
Leaf Spot/Melting Out	XXXX	XXX	----	----
Pythium Blight/Root Rot	XX	----	XXXX	----
Rust	XXX	XXX	----	----
Spring Dead Spot	----	----	----	----
Summer Patch	----	----	----	X
Take All Patch	----	----	----	----
Yellow Patch	----	XX	----	XX

Disease	Phosphonate	Qol		
	fosetyl-AI	azoxystrobin*	pyraclostrobin	trifloxystrobin
Algae	----	----	----	----
Anthracnose	----	XXXX	XXX	XX
Brown Patch	----	XXXX	XXXX	XXX
Dollar Spot	----	----	XX	X
Fairy Ring	----	XXX	----	----
Gray Leaf Spot	----	XXXX	XXX	XX
Large Patch	----	XXXX	X	----
Leaf Spot/Melting Out	----	XXXX	XXX	----
Pythium Blight/Root Rot	XXXX	XX	X	X
Rust	----	XXXX	----	----
Spring Dead Spot	----	XXXX	----	----
Summer Patch	----	XXXX	XX	XXX
Take All Patch	----	XXXX	X	----
Yellow Patch	----	----	----	----

This efficacy table has been prepared based on Vincelli, P., and A.J. Powell. 2006; L. Treadway handouts, Turfgrass Disease Update at North Carolina Turfgrass Association meeting, 2005; Fungicide and Nematicide Tests - APS several issues; L. Burpee research results and personal observations, and A. Martinez research results and personal observations.

XXXX Excellent control when conditions highly favorable for disease development.

XXX Good control when conditions highly favorable for disease development.

XX Good control when disease pressure is moderate.

X Good control when disease pressure is low.

Methods to Maximize Efficacy of Turfgrass Fungicides

- All fungicides are not equally effective on all diseases. Proper selection is very important on disease management.
- Read the label directions carefully before applying fungicide.

- Apply fungicides at the rate specified in the label.
- Use compatible tank mixes at recommended label rates.
- The best control is achieved by applying fungicides preventively.
- Fungicides should be sprayed when air temperatures are between 60 degrees F and 85 degrees F (15.3 degrees C and 29.4 degrees C).
- Avoid turfgrass stress (drought or temperature) before or at the time of application.
- Use proper sprayer to deliver appropriate coverage.
- Fungicides should stay on the foliage for at least 6 h for most effective control.
- Some fungicides have to be watered-in for proper place of action.
- Do not apply fungicides if rain is expected within 3-4 h (ideally 12 h after application).
- Delay mowing as much as possible to give the fungicide a chance to work (should follow the one-third rule).
- Use enough water when applying fungicide (usually 2 gallons/1,000 sq feet will give adequate coverage).
- Water pH for dilution or mix should be between 6-7.
- Do not apply fungicides when conditions are windy. Wind velocity tends to be the lowest early in the morning and late in the afternoon.
- When using granular materials, best results are obtained if soil is moist.
- Keep traffic off the area at least 2-3 hours after application.
- Be patient if an application appears to have produced no results. Some fungicide application results can be seen months later.

Turfgrass Fungicide Resistance Management

In general, fungicide resistance can be defined as an adjustment by a fungal population to the use of a particular fungicide. This adjustment will result in reduced effectiveness and control of the particular fungicide in question. The most important thing to remember when using fungicides is to read the label provided with them. Only apply the fungicide at the rate that is allowed by the law, and only spray the chemical on the provided label spray cycle.

Decreasing the rate or decreasing the number of days between sprays on your own will only increase the likelihood of developing a resistant fungal population. Some fungicides have a higher risk of creating a resistant fungal population. An example of a chemical family that has developed resistance is the phenylamides. One specific fungicide in this family is Subdue (metalaxyl).

In general, protectant fungicides have a low risk of fungal populations developing resistance to them. Systemic fungicides are most at risk. Systemic fungicides act on a single site in the fungal cell, and their mode of action is so specific that a simple natural mutation may occur in the target fungus. This can lead to the buildup of resistant populations of fungi. Widespread or repeated use of the fungicide will then result in chemical control failure. The four systemic fungicide families most at risk for resistance

are the benzimidazoles, dicarboxamides, demethylation inhibitors (DMIs), and the strobilurins.

Strategies that can be implemented to reduce the onset of resistance are aimed at delaying the development of fungicide resistance. The most effective strategies include:

Use fungicides only when you need to. In some cases, cultural control measures can be implemented to decrease disease and reduce the use of chemical controls.

Alternate fungicides that have different modes of action or sites of action (refer to [Table 1](#)). This will act to reduce the time of exposure that a fungus has to any one mode of action. For example, there are several different chemistries that can be used to control dollar spot. Not all of these chemistries are in the same chemical family. Members of the nitriles (chlorothalonil), anilides (boscalid), demethylation inhibitors (fenarimol), and dithiocarbamates (mancozeb) all have the ability to control dollar spot. Also, not all of the chemistries that can be employed are systemic fungicides. Using a variety of products that will limit the exposure of *Sclerotinia homoeocarpa* to any one formulation reduces the risk of a resistance build-up in the fungal population.

Turfgrass Fungicide Costs

Cost of fungicide requires a range of consideration including: price from vendor, cost per ounce, label application rates, application intervals, and cost per day.

Vendor Price Lists. This will include the actual price of the fungicide. Lists will be more useful if they contain size of the product and quantity per unit. Other considerations include availability of other products within the same chemical group, past performance of the fungicide, diseases that the fungicide controls, protection interval, fungicide resistance management and date that the product will be delivered.

Cost per ounce. Convert the price to a cost per ounce by taking the total cost of the product and dividing by the total number of ounces.

Application interval. A key element to consider when purchasing a fungicide is the application interval or how long is the fungicide going to control a particular pathogen.

Application rate. Factors to consider include: labeled rate, disease pressure and disease to control. Many labels include preventative and curative rates.

Cost per day. A valuable indicator to evaluate the cost of a particular fungicide is the cost of control per day. This can be calculated by taking the application rate then multiplying it by the cost of the product on a per ounce basis, then dividing the result by the application interval.

Product	Rate/1000 sq ft (max)	Application Interval (max)	Cost per ounce \$	Cost per 1000 sq ft \$	Cost per day \$
Product A	0.4 oz	28 days	42.00	16.80	0.60
Product B	2.0 oz	28 days	5.00	10.00	0.35
Product C	10 oz	14 days	0.88	8.80	0.62

Turfgrass Fungicide Internet Resources

1. www.cdms.net from Crop Data Management Systems. There are more than 1,600 product labels and over 4,400 MSDS, searchable products, update new label registration.
2. www.ca.uky.edu/agc/pubs/ppa/ppa1/ppa1.pdf. *Chemical control of Turfgrass Disease 2006*. Yearly update on turfgrass fungicides tailored for the state of Kentucky. Written and maintained by Dr. P. Vincelli, and A. J. Powell.
3. *Georgia Pest Management Handbook*. www.ent.uga.edu/pmh. Comprehensive yearly special bulletin published by Cooperative Extension, University of Georgia College of Agricultural and Environmental Sciences.
4. *2006 Turfgrass Pest Control: Recommendations for Professionals*. http://www.commodities.caes.uga.edu/turfgrass/georgiaturf/Publicat/1640_Recommendations.htm. Yearly special bulletin tailored for turfgrass professionals published by University of Georgia Cooperative Extension, College of Agricultural and Environmental Sciences in cooperation with the Georgia Turfgrass Association.
5. *Turfgrass Diseases in Georgia: Identification and Control*. <http://pubs.caes.uga.edu/caespubs/pubcd/B1233.htm>. Martinez, A. et al. 2005. Comprehensive publication with description of turfgrass diseases and practical recommendations for disease management.
6. **FRAC. Fungicide Resistance Action Committee**. <http://www.frac.info/frac/index.htm>. FRAC is a Specialist Technical Group of CropLife International. The purpose of FRAC is to provide fungicide resistance management guidelines to prolong the effectiveness of “at risk” fungicides and to limit crop losses should resistance occur.

Turfgrass Fungicide Manufacturers and Distributors

AGBIO

<http://www.agbio-inc.com/>

9915 Raleigh St. Westminster, COUSA 80031

Phone: 877.268.2020

AGRAQUEST

<http://www.agraquest.com/>

1530 Drew Avenue • Davis, CA 95616-1272

p/(530)750-0150

info@agraquest.com

ANDERSONS Golf Products

<http://www.andersonsgolfproducts.com/>

ARYSTA LIFESCIENCES

Arysta LifeScience North America Corporation

15401 Weston Parkway, Suite 150

Cary, NC 27513

Phone: 919-678-4900

Customer Service:

Phone: 1-800-358-7643

<http://www.arysta-na.com/>

BASF

<http://www.turffacts.com>

BASF Professional Turf

26 Davis Drive

Research Triangle Park, NC 27709

(800) 545-9525

BAYER

http://www.bayercropscience.com/bayer/cropscience/cscms.nsf/id/Home_EN

<http://www.bayercropscienceus.com>

<http://www.bayerprocentral.com/green/>

BIOSAFE SYSTEMS

<http://www.biosafesystems.com>

36 Commerce Street

Glastonbury, CT 06033

Phone: 860.657.2211

CHEMTURA

<http://www.arysta-na.com>

CLEARY

<http://www.clearychemical.com>

178 Ridge Road, Dayton, NJ 08810.

Phone: 1-800-524-1662

DOW AGROSCIENCES

<http://www.dowagro.com/homepage/index.htm>

Global Headquarters
Dow AgroSciences LLC
9330 Zionsville Road
Indianapolis, IN 46268
Telephone: 1-317-337-3000

DUPONT

[http://www2.dupont.com/Turf and Ornamental Green/en_US/](http://www2.dupont.com/Turf_and_Ornamental_Green/en_US/)

GRIFFIN LCD

<http://www.griffinllc.com>
1-888-6DUPONT (638-7668)

LESCO, Inc.

1301 East 9th Street
Suite 1300
Cleveland, OH 44114-1849
www.LESCO.com
phone: 800.321.5325 (inside the U.S.)
phone: 216.706.9250

NOVOZYMES

<http://www.novozymes.com/cgi-bin/bvisapi.dll/solutions/solutions.jsp?cid=-11287&id=29064>

SYNGENTA

http://www.syngenta.com/country/us/index_en.aspx

Syngenta Corporation
2200 Concord Pike
P. O. Box 8353
Wilmington, DE 19803-8353
Ph : (302) 425-2000 or 1-800-759-4500
Fax: (302) 425-2001

Syngenta Crop Protection

Syngenta Crop Protection, Inc.
Regional Headquarters
P.O. Box 18300
Greensboro, NC 27409
Ph : (336) 632-6000

VALENT

<http://www.valent.com>
800-89-VALENT (898-2536)

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Disclaimer

1. Listing fungicides implies no product endorsement by the University of Georgia nor its representatives. Omission and criticism of products not mentioned is neither implied nor intended.
2. This bulletin is for informational purposes only. The University of Georgia does not accept any responsibility for omissions, errors or future amendments.
3. Always read and follow label directions.

ATTENTION! Pesticide Precautions

1. Observe all directions, restrictions and precautions on fungicide labels. It is dangerous, wasteful and illegal to do otherwise.
2. Store all fungicides in original containers with labels intact and behind locked doors. **“KEEP PESTICIDES OUT OF REACH OF CHILDREN.”**
3. Use fungicides at correct label dosage and intervals to avoid illegal residues or injury to plant and animals.
4. Apply fungicides carefully to avoid drift or contamination of non-target areas.
5. Surplus fungicides and containers should be disposed of in accordance with label instructions so that contamination of water and other hazards will not result.

6. Follow directions on the fungicide label regarding restrictions as required by State and Federal Laws and Regulations.
7. Avoid any action that may threaten an Endangered Species or its habitat. Your County Extension Agent can inform you of Endangered Species in your area, help you identify them and through the Fish and Wildlife Service Office identify actions that may threaten Endangered Species or their habitat.

Trade names are used only for information.

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J. Scott Angle, Dean and Director