

Pest Management Guidelines

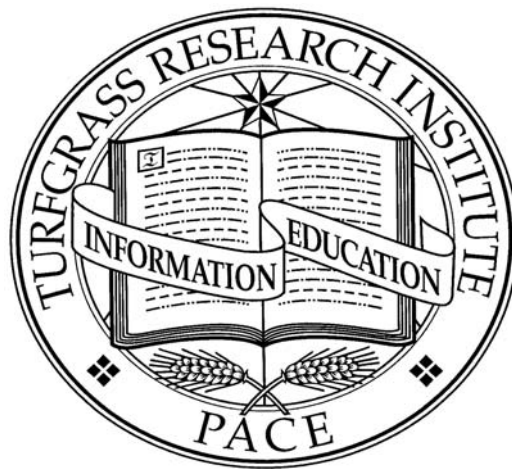


Table of Contents

Table Number	Page number
Table 1. Turf insect management.....	3
Table 2. Insect common and scientific names.....	3
Table 3. Timing curative insect control:.....	4
Table 4. Timing preventive insect control:.....	5
Table 5. Activity spectra of insecticide active ingredients on key turf insects:.....	6
Table 6. Cultural and biological control practices for key insect pests.....	6
Table 7. Commonly used contact and systemic fungicides.....	7
Table 8. Fungicide active ingredients and the diseases they control.....	7
Table 9. Timing Disease Control.....	8
Table 10. Turf Disease Prevention: Monitoring and Cultural Practices.....	8
Table 11. Sources for turf pesticide label information.....	8
Table 12. Cultural management practices for weeds.....	9
Table 13. Timing herbicide applications.....	9
Table 14. Pre-emergence vs. post-emergence strategies.....	9
Table 15. Efficacy of pre-emergence herbicides for weed control.....	10
Table 16. Efficacy of post-emergence herbicides for weed control.....	11
Table 17. Sensitivity of turf species to pre-emergence herbicides.....	12
Table 18. Sensitivity of turf to post-emergence herbicides.....	13
Table 19. Insecticide resistance management groups.....	14
Table 20. Fungicide resistance management groups.....	14
Table 21. Herbicide resistance management groups.....	15

Table 1. TURF INSECT MANAGEMENT

CONTACT INSECTICIDES	
<ul style="list-style-type: none"> • Best activity on insects that feed on foliage • Less activity when insects feed on roots, inside plants • Activity reduced by mowing, water, weather • Apply in 1-2 ga/1000ft² (4 – 8 liters/100 meters²). Do not water in • Usually, multiple applications per season are required 	
ACTIVE INGREDIENT	TRADE NAME
acephate	Orthene
bifenthrin	Talstar
carbaryl	Sevin
cyfluthrin	Tempo
lambda cyhalothrin	Scimitar
chlorpyrifos	Dursban, Pageant
deltamethrin	Deltagard
fipronil**	Chipco Choice, Firestar**
hydramethylnon***	Amdro, Maxforce, Siege
spinosad	Conserve

SYSTEMIC INSECTICIDES	
<ul style="list-style-type: none"> • Effective on insects that feed on foliage or roots • Absorbed by plant and distributed inside the plant via the vascular system • Less prone to break-down by water, weather, mowing • Apply in 2-4 ga/1000 ft² (8 – 16 liters/100 meters²) and water in • Usually only one application per season is required 	
ACTIVE INGREDIENT	TRADE NAME
abamectin***	Ascend, Avid, Varsity
halofenozide	Mach 2
imidacloprid	Merit
thiamethoxam*	Meridian*
trichlorfon	Dylox, Proxol

*awaiting EPA registration **fipronil works on contact and also when ingested ***available as fire ant baits

Table 2. INSECT COMMON AND SCIENTIFIC NAMES

Arranged by common name	
COMMON NAME	SCIENTIFIC NAME
Annual bluegrass weevil	<i>Listronotus maculicollis</i> (formerly <i>Hyperodes</i>)
Armyworms	<i>Pseudaletia unipuncta</i>
Asiatic garden beetle	<i>Maladera castanea</i>
Bermudagrass scale	<i>Odonaspis ruthae</i>
Billbugs	<i>Sphenophorus spp.</i>
Black cutworm	<i>Agrotis ipsilon</i>
Black turfgrass ataenius	<i>Ataenius spretulus</i>
Chinch bugs	<i>Blissus spp.</i>
Cicada killer wasps	<i>Sphecius speciosus</i>
Crane flies	<i>Tipula spp.</i>
Earthworms (night crawlers)	<i>Lumbricus</i>
European chafer	<i>Rhizotrogus majalis</i>
Fall armyworm	<i>Spodoptera frugiperda</i>
Green June beetle	<i>Cotinis nitida</i>
Ground pearls	<i>Margarodeds spp.</i>
Harvester ants	<i>Pogonomyrmex spp.</i>
Japanese beetle	<i>Popillia japonica</i>
Masked chafers	<i>Cyclocephala spp.</i>
May beetles	<i>Phyllophaga spp.</i>
Mole crickets	<i>Scapteriscus</i>
Oriental beetle	<i>Exomala orientalis</i>
Red imported fire ant	<i>Solenopsis invicta</i>
Rove beetles	<i>Staphylinidae</i>
Sod webworms (cool season)	<i>Parapediasia, Pediasia, Crambus, Fissicrambus, Tehama</i>
Sod webworms (warm season)	<i>Herpetogramma spp.</i>
Tarantula hawk wasps	<i>Pepsis spp.</i>
Turfgrass & nuisance ants	<i>Lasium neoniger</i>
Yellow jackets	<i>Vespidae</i>

Arranged by scientific name	
SCIENTIFIC NAME	COMMON NAME
<i>Agrotis ipsilon</i>	Black cutworm
<i>Ataenius spretulus</i>	Black turfgrass ataenius
<i>Blissus spp.</i>	Chinch bugs
<i>Cotinis nitida</i>	Green June beetle
<i>Cyclocephala spp.</i>	Masked chafers
<i>Exomala orientalis</i>	Oriental beetle
<i>Herpetogramma spp.</i>	Sod webworms (warm season)
<i>Lasium neoniger</i>	Turfgrass & nuisance ants
<i>Listronotus maculicollis</i> (formerly <i>Hyperodes</i>)	Annual bluegrass weevil
<i>Lumbricus</i>	Earthworms (night crawlers)
<i>Maladera castanea</i>	Asiatic garden beetle
<i>Margarodeds spp.</i>	Ground pearls
<i>Odonaspis ruthae</i>	Bermudagrass scale
<i>Parapediasia, Pediasia, Crambus, Fissicrambus, Tehama</i>	Sod webworms (cool season)
<i>Pepsis spp.</i>	Tarantula hawk wasps
<i>Phyllophaga spp.</i>	May beetles
<i>Pogonomyrmex spp.</i>	Harvester ants
<i>Popillia japonica</i>	Japanese beetle
<i>Pseudaletia unipuncta</i>	Armyworms
<i>Rhizotrogus majalis</i>	European chafer
<i>Scapteriscus</i>	Mole crickets
<i>Solenopsis invicta</i>	Red imported fire ant
<i>Sphecius speciosus</i>	Cicada killer wasps
<i>Sphenophorus spp.</i>	Billbugs
<i>Spodoptera frugiperda</i>	Fall armyworm
<i>Staphylinidae</i>	Rove beetles
<i>Tipula spp.</i>	Crane flies
<i>Vespidae</i>	Yellow jackets

Table 3. TIMING CURATIVE INSECT CONTROL:

Timing of threat periods and management activities for key insect pests of turf. The threat temperature is a rough guideline that indicates when insects are likely to begin causing damage on golf course turf.

Insect	Threat * temperature		Monitoring (begin at threat temp. unless otherwise noted)	Control Measure
	F	C		
Annual bluegrass weevil	>55	>13	Monitor for adult weevils, starting at avg air temp >50F (10C)	If adult weevils detected, apply contact product against adults, 2 wks after adults 1 st appear
Ants (nuisance)	>65	>18	Monitor for foraging ants.	If detected, apply labeled ant product at entrance to mounds
Armyworms	>60	>16	Monitor for caterpillars w/soap drench	Apply contact product when larval numbers are high enough for concern
Bermudagrass scale	>65	>18	Monitor for eggs & crawlers in damaged patches of turf.	If detected scale, fertilize and irrigate to promote recovery. No effective products are labeled
Billbugs	>65	>18	Monitor for adults on paved areas, starting at avg. air temp>62F (17C)	If adult billbugs detected, apply contact product against adults, 2 wks after adults 1 st appear
Cicada killers & tarantula hawk wasps	>65	>18	Monitor for flying wasps	Treat burrows with contact product, but only if completely necessary; these are usually beneficial insects!
Chinch bug, hairy (cool season turf)	>60	>16	Monitor for chinch bugs (all stages)	Apply contact product when numbers are high enough for concern
Chinch bug, southern (warm season turf)	>55	>13	Monitor for chinch bugs (all stages)	Spot treat w/contact product when numbers are high enough for concern
Crane flies	>45	>7	Monitor for larvae w/cup cutter	Apply contact product when larval numbers are high enough for concern
Cutworms	>55	>13	Monitor for caterpillars w/soap drench	Apply contact product when larval numbers are high enough for concern
Fall armyworms	>65	>18	Monitor for caterpillars w/soap drench	Apply contact product when larval numbers are high enough for concern
Fire ants	All year		Monitor for foraging ants, starting when average air temp>65F (18C)	When detected, broadcast a bait formulation Follow several days later with a contact insecticide applied broadcast (in heavily trafficked areas) or to individual mounds (in areas of lower use)
Ground pearls	All year		Monitor roots of damaged turf, starting when avg air temp>75F (24C)	If ground pearls detected, fertilize and irrigate to promote recovery.
Mole crickets	>60	>16	No monitoring; use this option only if history of infestation	Target hatching eggs w/imidacloprid or fipronil when avg air temps > 65 F(18C)
Mole crickets	>60	>16	Monitor w/soap flush, starting when avg air temp >75F(24C)	If present, target small nymphs (<1/2" or <1.2 cm) w/contact product; or large nymphs & adults w/ beneficial nematodes
Sod webworms (cool season turf)	>70	>21	Monitor for caterpillars w/soap drench	Apply contact product when larval numbers are high enough for concern
Sod webworms (warm season turf)	>75	>24	Monitor for caterpillars w/soap drench	Apply contact product when larval numbers are high enough for concern

*average daily air temperature unless otherwise noted

NOTE: Most contact (curative) products require 1 or more follow-up applications, within 1-2 weeks of application

Table 4. TIMING PREVENTIVE INSECT CONTROL:

Timing of threat periods and management activities for key insect pests of turf. The threat temperature is a rough guideline that indicates when insects are likely to begin causing damage on golf course turf.

Insect	Threat temperature*		Monitoring (begin when threat temp is reached unless otherwise noted)	Control Measure
	F	C		
WHITE GRUBS	68-78	20-26	No monitoring. Control appropriate only if history of infestation.	Apply systemic product within 2-4 wks after reaching threat temperature. If multiple white grubs spp present, use insect w/lowest threat temperature to time application.
• Asiatic garden beetle	>75	>24	“	Apply systemic product 2-4 wks after reaching threat temperature.
• Black turfgrass ataenius	>68	>20	“	Apply systemic product 2-4 wks after reaching threat temperature.
• European chafer	>75	>24	“	Apply systemic product 2-4 wks after reaching threat temperature.
• Green June beetle	>78	>26	“	Apply systemic product 2-4 wks after reaching threat temperature.
• Japanese beetle	>75	>24	“	Apply systemic product 2-4 wks after reaching threat temperature.
• Masked chafers	>73	>23	“	Apply systemic product 2-4 wks after reaching threat temperature.
• May/June beetles	>68	>20	“	Apply systemic product 2-4 wks after reaching threat temperature.
• Oriental beetle	>73	>23	“	Apply systemic product 2-4 wks after reaching threat temperature.
OTHER PREVENTIVELY CONTROLLED INSECTS				
Annual bluegrass weevil	>55	>13	Monitor for adult weevils, starting at avg air temp >50F (10C) OR	Apply systemic product against grubs, 4 wks after adults appear
Annual bluegrass weevil	>55	>13	No monitoring. Appropriate only if history of infestation	Apply systemic product against grubs 2 wks after reaching threat temperatures
Billbugs	>65	>18	Monitor for adults on paved areas, starting at avg. air temp>62F (17C) OR	Apply systemic product against grubs, 4 wks after adults appear
Billbugs	>65	>18	No monitoring. Appropriate only if history of infestation)	Apply systemic product against grubs within 2 wks after reaching threat temperature.
Earthworms	>45	>7	Monitor for earthworm casts	Institute sand topdressing program on fairways at least 4X/year during periods of active turf growth only

*average daily air temperature unless otherwise noted

NOTE: Most systemic products (imidacloprid, halofenozide) applied against soil pests are applied 1X/ season, & have 2-3 months residual activity. Follow-up applications are required only in warm locations with long (>3 months) periods of threat from damage

Table 5. Activity spectra of insecticide active ingredients on key turf insects:

Contact (foliar) products are printed in green; and systemic (soil) insecticides in red. P = preventive control; C = curative control; P/C = both preventive and curative control and B= Bait Always read the most recent version of product labels to insure compliance with all use instructions.

INSECT PEST	STAGE		INSECTICIDE ACTIVE INGREDIENT													
	Larvae	Adults	Acephate	Abamectin	Bifenthrin	Carbaryl	Cyfluthrin	λ cyhalothrin	Chlorpyrifos	Deltamethrin	Fipronil	Halofenozide	Hydramethylnon	Imidacloprid	Spinosad	Trichlorfon
CONTROL TARGET = ROOTS (SOIL) OR INSIDE PLANT																
Annual bluegrass weevil	X											P		P		
Billbugs	X											P		P		
Mole crickets	X	X	C		C		C	C		C	C			P/C		
White grubs, including:	X		P/C			C*						P		P		P/C
• Asiatic garden beetle	X		P/C			C*						P		P		P/C
• Black turfgrass ataenius	X		P/C			C*						P/C		P/C		P/C
• European chafer	X		P/C			C*						P**		P**		P/C
• Green June beetle***	X		P/C			C*						P		P		P/C
• Japanese beetle	X		P/C			C*						P		P		P/C
• Masked chafers	X		P/C			C*						P		P		P/C
• May and June beetles	X		P/C			C*						P		P		P/C
• Oriental beetle	X		P/C			C*						P**		P**		P/C
CONTROL TARGET = FOLIAGE or SOIL SURFACE																
Ants (turfgrass, nuisance)		X	C		C	C	C	C	C	C	C					
Annual bluegrass weevil		X			C		C	C	C	C						
Billbugs		X					C	C	C	C						
Chinch bugs	X	X	C		C	C	C	C	C	C						
Crane flies (leatherjackets)	X		C			C				C						
Cutworms and armyworms	X		C		C	C	C	C	C	C		C			C	C
Fire ants		X	C	B	C	C	C	C	C	C	C		B		C	
Mites	X	X			C		C	C	C	C						C
Sod webworms	X		C		C	C	C	C	C	C		C			C	C

*carbaryl curative activity on white grubs is fair to moderate only; ** Oriental beetle & European chafer may be less susceptible to imidacloprid and halofenozide than other white grubs. ***Green June beetle is less susceptible to halofenozide than to imidacloprid.

Table 6. Cultural and biological control practices for key insect pests

Armyworms, chinch bugs, mites, sod webworm	Switch to resistant varieties
Bermudagrass scale	Fertilize and irrigate to mask damage and promote recovery
Black turfgrass ataenius	Avoid organic fertilizers
Earthworms (nightcrawlers)	Institute sand topdressing program on fairways at least 4X/year during periods of active turf growth only. Avoid organic fertilizers
Green June beetle	Avoid organic fertilizers
Ground pearls	Fertilize and irrigate to mask damage and promote recovery
Mole crickets	Target large nymphs and adults (spring or fall) with beneficial nematodes (Nematac/ <i>Steinernema scapterisci</i>)

Table 7. Commonly used contact and systemic fungicides

CONTACT FUNGICIDES	
<ul style="list-style-type: none"> • Work by coating the outside of the foliage with a fungicidal protective shield • Protects older, senescing plants from foliar disease • Not effective on root diseases • Activity reduced by mowing, water, weather 	
ACTIVE INGREDIENT	TRADE NAMES
chlorothalonil	Concorde, Daconil, Echo, Manicure, Spectro, Thalonil
etridiazole	Koban, Terrazole
fludioxonil	Medallion
mancozeb	Dithane, Fore, Mancozeb, Protect, Pentathlon
PCNB (quintozene)	Defend, Engage, Penstar, Revere, Terraclor, Turfcide
thiram	Thiram, Spotrete

SYSTEMIC FUNGICIDES	
<ul style="list-style-type: none"> • Effective on foliar and root diseases, but must be watered in if root diseases are the target • Absorbed by plant and distributed inside the plant via the vascular system • Because they act internally, systemics are less prone to break-down by water, weather, mowing 	
ACTIVE INGREDIENT	TRADE NAMES
azoxystrobin	Heritage
fenarimol	Patchwork, Rubigan
flutolanil	Prostar
fosetyl-aluminum	Aliette, Prodigy
iprodione	Chipco 26019, Chipco 26GT, Fungicide X, Iprodione-Pro
mefenoxam	Subdue Maxx, Quell
metalaxyl	Pythium Control, Subdue
myclobutanil	Eagle, Golden Eagle
propiconazole	Banner Maxx, Propiconazole-Pro
propamocarb	Banol
thiophanate-methyl	Cavalier, Cleary's 3336, Fungo, Systemic Fungicide
triadimefon	Accost, Bayleton, Fungicide VII, Granular Turf Fungicide
trifloxystrobin	Compass
vinclozolin	Curalan, Touche, Vorlan

Table 8. Fungicide active ingredients and the diseases they control.

Contact fungicides are in green print; systemic fungicides are in red. Because labeled uses frequently change over time, always check with the manufacturer for the most recent label changes before recommending or using products. Foliar or crown placement (low volume applications) = 1 – 2 gallons/1000 square feet; Soil (root) placement (high volume applications) = 2 – 4 gallons/1000 square feet or low volume applications watered in with approximately 0.1 inches of irrigation.

FUNGICIDE ACTIVE INGREDIENT

DISEASE Genus (common name)	APPLICATION TARGET	azoxystrobin	chlorothalonil	etridiazole	fenarimol	fludioxonil	flutolanil	fosetyl-al	iprodione	mancozeb	mefenoxam	myclobutanil	PCNB	propamocarb	propiconazole	thiophanate-methyl	thiram	triadimefon	trifloxystrobin	vinclozolin	
<i>Agrocybe</i> , <i>Bovista</i> (other basidiomycetes, fairy ring)	Soil (roots)																				
<i>Gaeumannomyces</i> (take-all patch and decline)																					
<i>Magnaporthe</i> (summer patch)																					
<i>Ophiospherella</i> (necrotic ring spot)																					
<i>Ophiospherella</i> (spring dead spot)																					
<i>Pythium</i> (root rot)																					
<i>Colletotrichum</i> (anthracnose)	Foliage																				
<i>Curvularia</i> , <i>Bipolaris</i> (blights/leaf spots)																					
<i>Lanzia</i> (<i>Sclerotinia</i> , dollar spot)																					
<i>Pyricularia</i> (gray leaf spot)																					
<i>Microdochium</i> (fusarium patch)																					
<i>Oscillatoria</i> (cyanobacteria, algae)																					
<i>Pythium</i> (blight)																					
<i>Rhizoctonia</i> (brown patch/yellow patch)																					
<i>Sclerotium</i> (southern blight)																					
<i>Typhula</i> (gray snow mold)																					

Table 9. Timing Disease Control

Disease	Threat Temperature	Disease	Threat Temperature
Anthracnose	≥ 65	Pythium Blight	≥ 70
Bipolaris Leaf Spot	≥ 70	Rapid Blight	≤ 65
Brown Patch	≥ 70	Snow Mold	≤ 62
Curvularia Blight	≥ 70	Southern Blight	≥ 70
Cyanobacteria	≥ 68	Spring Dead Spot	≥ 65
Dollar Spot	≥ 65	Summer Patch	≥ 72
Fairy Ring	≥ 70	Take-all Patch	≥ 65
Gray Leaf Spot	≥ 75	Red thread	≥ 65
		Bermuda decline	≥ 75

Table 10. Turf Disease Prevention: Monitoring and Cultural Practices

Monitoring	Cultural Practices, cont.
Monitor soil and air temperatures	Manage thatch
Scout greens weekly when air temperatures exceed 72F	Schedule monthly venting, and deep tine aeration in spring
Confirm disease diagnoses with a diagnostic lab	Manage irrigation to prevent excess water and drought
	Remove moisture from greens in morning
Cultural Practices	Leach when needed for salinity management
Balance nutrition (especially nitrogen)	Increase height of cut if necessary
Manage traffic and compaction	Remove branches, entire trees to improve air movement or decrease shade

Table 11. Sources for turf pesticide label information

Company	Website
BASF	spd.basf-corp.com/turf/home.asp
Bayer	bayerprocentral.com/index.html
Cleary Chemical	clearychemical.com/
Crop Data Mgt Systems *	cdms.net
C and P Press**	cppress.com
Dow	dowagro.com/turf/index.htm
EPA	epa.gov
FMC	fmc-apgspec.com/labels.htm
Griffin LLC	griffinllc.com/specialty/products/pr_tno1.htm
Monsanto	monsanto.com/monsanto/us_ag/layout/crop_pro/all_labels_msds.asp
Riverdale Chemical	riverdalecc.com/
Syngenta	syngentaprofessionalproducts.com/
Valent	valent.com/

*Free access to labels & MSDS's. ** Labels from most companies in a searchable data base (\$50 fee per year)

Table 12. CULTURAL MANAGEMENT PRACTICES FOR WEEDS.

These practices should be regularly scheduled for improved turf health in general, but can be targeted in problem areas for management of the specific weeds listed below.

Goal	Practice	Target weeds
Decrease compaction	aerification, topdressing, traffic management	Goosegrass, knotweed and annual bluegrass thrive in compacted soils
Manage wet, waterlogged areas	Optimize irrigation uniformity, improve drainage, aerify and topdress	Kyllinga and sedges prefer wet areas
Manage dry soils	Optimize irrigation uniformity, remove trees whose roots compete for water	Spurge, knotweed, sorrel, plantain prefer dry areas
Reduce shade	Tree management program	All weeds: Turf that receives <3 hrs sun/day will be stressed and prone to weed invasion
Optimize soil fertility	Conduct soil tests 2X/yr; address deficiencies and excesses	All weeds
Avoid thinning turf	Avoid products that stress turf, avoid damage due to insects, diseases	All weeds

Table 13. TIMING HERBICIDE APPLICATIONS/WEED THREAT TEMPERATURES

Common Name	Scientific name	Activity	Timing/Threat temperature*
Barnyardgrass	<i>Echinochloa</i>	Pre-emerge herbicides	When air temperatures reach >60F (16C) for 3 days in a row
Crabgrass	<i>Digitaria</i>	Pre-emerge herbicide	When air temperatures reach >50F (10C) for 3 days in a row
Foxtails	<i>Setaria</i>	Pre-emerge herbicide	When air temperatures reach >65F (18C) for 3 days in a row
Goosegrass	<i>Eleusine</i>	Pre-emerge herbicide	When air temperatures reach >60F (16C) for 3 days in a row
Annual bluegrass	<i>Poa annua</i>	Pre-emerge herbicide	Fall/winter, when air temperatures drop to <75F (24C) for 3 days in a row
Weeds controlled post-emergence		Begin weekly monitoring, mapping, record keeping	When air temperatures reach >50F (10C)

*average daily air temperatures

NOTE: Most pre-emerge products have 2-3 months of residual activity. Split applications, spaced 2-3 months apart, can be used to extend the period of control.

Table 14. Pre-emergence vs. post-emergence strategies

Pre-emerge strategies	Post-emerge strategies
Used before weeds occur	Used after weeds are present
Used when there is a history of infestation	Injury to existing turf an issue
No effect on existing weeds	Soil movement a potential issue
Watering in usually required	Usually on perennial weeds (broadleaf weeds, nutsedges, kyllinga)
Examples: <ul style="list-style-type: none"> maintain dense stand of turf prodiamine or oxadiazon for Poa control pendimethalin for goosegrass 	Examples: <ul style="list-style-type: none"> spot treatments with glyphosate Poa control with ethofumesate Moss control with chlorothalonil, soaps

Table 15. Efficacy of pre-emergence herbicides for weed control

(Always read the most recent version of product labels to insure compliance with all use instructions)

	ATR	BEN	BES	DCP	DIT	FEN	ISO	ORY	OXA	PEN	PRD	PRO	SIM	
Annual bluegrass	C	C	C	C	C	C	N	C	C	C	C	C	C	Annual bluegrass
Barnyardgrass	C	C	C	C	C		N	C	P	C	C	C	C	Barnyardgrass
Chickweed	C	P	N	P	C	N	C	C	N	C	C	C	C	Chickweed
Crabgrass	P	C	C	C	C	N	N	C	C	C	C	P	P	Crabgrass
Dallisgrass					C									Dallisgrass
Dandelion							C							Dandelion
Foxtail	P	C	C	C	C	N	N	C	C	C	C	C	P	Foxtail
Goosegrass	N	P	P	P	C	N	N	C	C	C	C	P	N	Goosegrass
Henbit	C	P	N	N	P	N	C	P	P	P	P	P	C	Henbit
Knotweed	C	C	N	P	C		C	C	C	C	C	C	C	Knotweed
Kyllinga		C	C	C	C		C	C	C	C	C	P		Kyllinga
Speedwell (veronica)	C	P	N	C	C	N	C	C	P	C	P	C	C	Speedwell (veronica)
Smutgrass	C	C		P	C		C	C	C	C	C	C	C	Smutgrass
Sorrel (oxalis)	C													Sorrel (oxalis)
Spurge	C	N	N	P	C	N	C	P	P	C	P	N	P	Spurge
Spurweed (Lawn burweed, Solvia)	C	N	N	N		N	C	P	P	P	P	N	C	Spurweed (Lawn burweed, Solvia)
Swinecress		N	N	N			C		C	P		N		Swinecress
Violet							C							Violet

PRE-EMERGENCE PRODUCTS			
ATR	Atrazine	ORY	Oryzalin
BEN	Benfen	OXA	Oxadiazon
BES	Bensulide	PEN	Pendimethalin
DCP	DCPA	PRD	Prodiamine
DIT	Dithiopyr	PRO	Pronamide
FEN	Fenarimol	SIM	simazine
ISO	Isoxaben		

RATINGS	
C	control
P	Partial control
N	No control

Post-emergence control of silvery thread moss, *Bryum argenteum*

- Chlorothalonil (Daconil, Echo)
- Mancozeb/copper hydroxide (Junction)
- Sodium carbonate peroxyhydrate (Terracyte)
- Spot treatment w/fatty acids/soaps

Growth regulators for annual bluegrass (*Poa annua*) management

- Ethephon for seedhead suppression (Proxy); increased activity in combination with trinexapac-ethyl (Primo)
- Flurprimidol (Cutless) for *Poa* growth suppression
- Mefluidide for seedhead suppression (Embark)
- Paclobutrazole (Trimmit, TGR Turf Enhancer) for *Poa* growth suppression

Table 16. Efficacy of post-emergence herbicides for weed control (Always read the most recent version of product labels to insure compliance with all use instructions)

	ATR	CHL	CLO	24D	DIC	DIT	DSM	ETH	FOR	FLU	GLY	HAL	IMA	METR	METS	MSM	PRO	QUIN	RIM	SIM	TRI
Ann.bluegrass	C	C				P		C	C		C			C	C		C		C	C	
Barnyardgrass							C			C	C			C		C		C			
Bermudagrass								C		C	C										
Carrot (wild), Qun Ann lace	C			C	C								C	C	C					C	C
Chickweed	C	C		P	C						C		C		C					C	P
Clover	C		C	P	C						P		C	C	C			C		C	C
Crabgrass						C	C			C	C			P		C		C			
Dallisgrass							C			P	C					C					
Dandelion	C		C	C	P						C				C					C	P
English daisy			P		P						C										
Foxtail										P	C										
Goosegrass										C	C			C		C					
Henbit	C	C		P	C						C		C	C	C					C	C
Kikuyugrass										C	C					P		C			P
Knotweed	C			P	C						P			C						C	C
Kochia				C											C						
Kyllinga							P				C	C				P					
Nutsedge, purple											P	C				P					
Nutsedge, yellow				P			P				P	C				P					
Plantain	C		C	C	P	P					C			C						C	P
Quackgrass							C			C				C		C		C			
Ryegrass	C	C							C	C	C					C		C		C	
Smutgrass	P			P	C		P				P					P				P	
Sorrel (oxalis)	C		P		P						C		C	C	C					C	C
Speedwell (veronica)	C														P					C	C
Spurge	C			P	P						C		C	C	C					C	C
Spurweed			C	C	P						C										
Swinecress	C				P						C		C		C					C	
Thistle	C													C	C					C	C
Violet	C												C	C						C	C
Wild garlic/onion				C									C		C						

ATR	Atrazine	FOR	Foramsulfuron	MSM	MSMA	RATINGS
CHL	Chlorsulfuron	FLU	Fluazifop	PRO	Pronamide	
CLO	Clopyralid	GLY	Glyphosate	QUIN	Quinclorac	C control
24D	2,4-D	HAL	Halosulfuron	RIM	Rimsulfuron	P partial control
DIC	Dicamba	IMA	Imazaquin	SIM	Simazine	
DSM	DSMA	METR	Metribuzin	TRI	Triclopyr	
ETH	Ethofumesate	METS	Metsulfuron			

Table 17. Sensitivity of turf species to pre-emergence herbicides
 (Modified from: UC IPM Pest Mgt Guidelines: ANR Publication 3365T)

PREEMERGENCE												
TURF SPECIES	<u>ATR</u>	<u>BEN</u>	<u>BES</u>	<u>FEN</u>	<u>DIT</u>	<u>ISO</u>	<u>ORY</u>	<u>OXA</u>	<u>PEN</u>	<u>PRD</u>	<u>PRO</u>	<u>SIM</u>
bentgrasses	S	S	T		R		S	S	S	S	S	
bermudagrass, common	R	T	T	T	T	T	R	T	T	T	T	D
bermudagrass, hybrid	R	T	T	T	T	T	R	T	T	T	T	D
bluegrass, Kentucky	S	T	T	T	T	T	S	T	R	R	S	
dichondra	S	S	T				T	S	T	R	R	
fescue, fine	S	T	T		R		S	T	T	T	S	
fescue, tall	S	T	T	T	T	T	S	T	T	T	S	
kikuyugrass		T	T					R	R	T		
ryegrasses	S	T	T	T		T	S	R	R	T	S	
St. Augustinegrass	T	T	T			T	T	R			S	T
zoysiagrass	T	T	T			T	S	R	R	T	S	T

RATINGS LEGEND

S = sensitive R = relatively tolerant T = tolerant D = dormant turf only

PRODUCTS

ATR = atrazine (Drexel Atrazine)
 BEN = benefin (Balan)
 BES = bensulide (Presan)
 DIT = dithiopyr (Dimension)
 FEN = fenarimol
 ISO = isoxaben (Gallery)
 ORY = oryzalin (Surflan)

OXA = oxadiazon (Ronstar)
 PEN = pendimethalin (PreM, Pendulum)
 PRD = prodiamine (Barricade)
 PRO = pronamide (Kerb)
 SIM simazine

NOTE: Always follow all use instructions on the product label for storage, handling, application and container disposal

Table 18. Sensitivity of turf to post-emergence herbicides
 (Modified from: UC IPM Pest Mgt Guidelines: ANR Publication 3365T)

POSTEMERGENCE																	
TURF SPECIES	ETH	QUI	CLO	DIC	DSM	FLU	GLY	HAL	SIM	MSM	PRO*	TRY	IMA	METR	CHL	METS	RIM
bentgrasses			T	R	R	S	S	T		S	S	S					
bermudagrass, common	D	R	T	T	T	S	S	T	D	T	T	R	R	R	T	T	T
bermudagrass, hybrid	D	R	T	T	T	R	S	T	D	T	T	S	R	R	T	T	T
bluegrass, Kentucky	T	T	T	T	T	S	S	T		R	S	T			T		
dichondra			T	S	R	T	S			S	R	S					
fescue, fine	R	R	T	T	T	T	S	T		T	S	T			R		
fescue, tall	T	T	T	T	T	S	S	T		T	S	T					
kikuyugrass				R	R	S	S			S		S					
ryegrasses	T	T	T	T	T	S	S	T		T	S	T					
St. Augustinegrass				S	S		S	T	R	S	S	S	T		R	R	
zoysiagrass		T	T	R	R	S	S	T	R	T	S	S	T		R	T	

RATINGS LEGEND

S = sensitive R = relatively tolerant T = tolerant D = dormant turf only

PRODUCTS

- ATR = atrazine (Drexel Atrazine)
- BEN = benefin (Balan)
- BES = bensulide (Presan)
- CHL = chlorsulfuron
- CLO = clopyralid (Stinger, Lontrel)
- DIC = dicamba (Banvel 4S)
- DIT = dithiopyr (Dimension)
- DSM = DSMA (Methar)
- ETH = ethofumesate
- FLU = fluazifop (Fusilade 2000)
- GLY = glyphosate (Roundup)
- HAL = halosulfuron (Manage)
- IMA = imazaquin
- ISO = isoxaben (Gallery)

- METR = metribuzin
- METS = metsulfuron
- MSM = MSMA
- NAP = napropamide (Devrinol)
- ORY = oryzalin (Surflan)
- OXA = oxadiazon (Ronstar)
- PEN = pendimethalin (PreM, Pendulum)
- PRD = prodiamine (Barricade)
- PRO = pronamide (Kerb)
- QUI = quinclorac
- RIM = rimsulfuron
- SIM = simazine
- TRY = triclopyr (Turflon)

Pesticide Resistance Management Groups: Pesticides are organized into Resistance Management Groups based on mode of action and chemical structure. In general, a pest that develops resistance to one pesticide within a group will probably be cross-resistant to other members of the group. Therefore, current resistance management strategies rely on **rotation** among different pesticide groups.

Table 19. Insecticide resistance management groups. Insecticide RAC (www.plantprotection.org/irac/).

ACTIVE INGREDIENT	TRADE NAME	INSECTICIDE GROUP NAME	GROUP #
Acephate	Orthene	acetyl choline esterase inhibitors	1
Carbaryl	Sevin	acetyl choline esterase inhibitors	1
chlorpyrifos	Dursban, Pageant	acetyl choline esterase inhibitors	1
trichlorfon	Dylox, Proxol	acetyl choline esterase inhibitors	1
fenprothrin	Chipco Choice	GABA-gated chloride channel antagonists	2
Bifenthrin	Talstar	sodium channel modulators	3
Cyfluthrin	Tempo	sodium channel modulators	3
deltamethrin	Deltagard	sodium channel modulators	3
λ cyhalothrin	Scimitar	sodium channel modulators	3
imidacloprid	Merit	acetyl chlorine receptor agonists/antagonists	4
spinosad	Conserve	acetyl chlorine receptor modulators	5
halofenozide	Mach 2	ecdysone agonist/disruptor	18

Table 20. Fungicide resistance management groups. Source: Fungicide RAC (www.frac.info)

ACTIVE INGREDIENT	TRADE NAMES	FUNGICIDE GROUP NAME	GROUP #	COMMENTS
thiophanate-methyl	Cavalier, Cleary's 3336, Fungo, Systemic Fungicide	MBC (methyl benzimidazole carbamates)	1	Resistance common for many diseases incl. dollar spot
iprodione	Chipco 26019, Chipco 26GT, Fungicide X	dicarboximides	2	Resistance known in some fungal species, incl. dollar spot
vinclozolin	Curalan, Touche, Vorlan	dicarboximides	2	
fenarimol	Patchwork, Rubigan	DMI (demethylation inhibitor) fungicides	3	Resistance known in some fungal species, incl. dollar spot
myclobutanil	Eagle, Golden Eagle	DMI	3	
propiconazole	Banner Maxx	DMI	3	
triadimefon	Accost, Bayleton, Fungicide VII, Granular Turf Fungicide	DMI	3	
mefenoxam	Subdue Maxx, Quell	Phenylamides	4	Resistance known in Pythium
metalaxyl	Pythium Control, Subdue	Phenylamides	4	
flutolanil	Prostar	carboxamides	7	No known resistance
azoxystrobin	Heritage	QoI: <u>includes strobilurins</u>	11	Resistance known in several fungal species, including gray leaf spot & anthracnose
pyraclostrobin	Insignia	QoI	11	
trifloxystrobin	Compass	QoI	11	
etridiazole	Koban, Terrazole	Aromatic hydrocarbons	14	Resistance known, but none on turf diseases to date
PCNB (quintozene)	Defend, Engage, Penstar, Revere, Terraclor, Turfcide	Aromatic hydrocarbons	14	
propamocarb	Banol	Carbamate fungicides	28	No resistance on turf diseases to date
fosetyl-al	Aliette, Prodigy	Phosphonates	33	No problems known
mancozeb	Dithane, Fore, Mancozeb, Protect, Pentathlon	Multi-site activity	M	Considered low risk for resistance; no signs of resistance developing
thiram	Thiram, Spotrete	Multi-site activity	M	
chlorothalonil	Concorde, Daconil, Echo, Manicure, Spectro, Thalonil	Multi-site activity	M	

Table 21. Herbicide resistance management groups.Source: Herbicide Resistance Action Committee (www.plantprotection.org/HRAC/)

Active ingredient	Trade Name	Herbicide Group	Group #
fenarimol	Rubigan	unclassified	
clethodim	Envoy	cyclohexanediones	A
fenoxaprop	Acclaim	aryloxyphenoxy-propionates	A
fluazifop	Fusilade 2000	aryloxyphenoxy-propionates	A
bispyribac	Velocity	pyrimidinylthiobenzoates	B
chlorsulfuron	Corsair	sulfonylurea	B
foramsulfuron	Revolver	sulfonylurea	B
halosulfuron	Manage	sulfonylurea	B
imazaquin	Image	imidazolinones	B
metsulfuron	Manor, Escort	sulfonylurea	B
rimsulfuron	TranXit	sulfonylurea	B
trifloxysulfuron	Monument	sulfonylurea	B
atrazine	Drexel, Atrazine, AAtrex, Purge.	triazines	C1
metribuzin	Sencor	triazinones	C1
simazine	Princep, Simazine	triazines	C1
siduron	Tupersan	ureas	C2
bentazon	Basagran	benzothiadiazinone	C3
bromoxynil	Buctril	nitriles	C3
oxadiazon	Ronstar	oxadiazoles	E
glyphosate	Roundup	glycines	G
glufosinate	Finale	phosphinic acids	H
asulam	Asulox, Asulam	carbamate	I
benefin	Balan	dinitroanilines	K1
DCPA	Dacthal W-75	benzoic acids	K1
dithiopyr	Dimension	pyridines	K1
oryzalin	Surflan	dinitroaniline	K1
pendimethalin	Pre-M, Pendulum	dinitroaniline	K1
prodiamine	Barricade	dinitroaniline	K1
pronamide	Kerb	benzamides	K1
trifluralin	Team 2G	dinitroaniline	K1
metolachlor	Pennant	chloroacetamides	K3
napropamide	Devrinol	acetamides	K3
isoxaben	Gallery	benzamides	L
bensulide	Betasan, Bensumec, Presan	phosphorodithioates	N
ethofumesate	Prograss	benzofuranes	N
2,4-d amine	2, 4-D	phenoxy-carboxylic-acids	O
clopyralid	Stinger, Lontrel	pyridine carboxylic acids	O
dicamba	Banvel, Vanquish	benzoic acids	O
mecoprop	MCP	phenoxy-carboxylic-acids	O
quinclorac	Drive	quinoline carboxylic	O
triclopyr	Turflon	pyridine carboxylic acids	O
dazomet	Basamid	unknown	Z
DSMA	Methar	unknown	Z
MSMA	MSMA, etc.	unknown	Z
pelargonic acid	Scythe	unknown	Z

