EC 699

CLEMSON UNIVERSITY

2014 Pest Control Guidelines for Professional Turfgrass Managers

This publication is also available at: **http://www.clemson.edu/extension/horticulture/turf/pest_guidelines/**

EC 699

2014 Clemson University Pest Control Guidelines for Professional Turfgrass Managers

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This guide supplies information on pesticides used for controlling pests in turfgrasses. Use pesticides safely to protect against human injury and harm to the environment. Diagnose your pest problem; select the proper pesticide, if one is needed; follow the label directions; and obey all federal, state, and local pesticide laws and regulations. Because of environmental risks, including water quality and wildlife toxicity and similar concerns, and risks of handling, some pesticides are classified as "RESTRICTED USE PESTICIDES". Such products bear this designation on their label and can be purchased and applied only by certified applicators. All other pesticides, classified as "GENERAL USE PESTICIDES", can be purchased and applied by anyone.

Use of brand names does not imply endorsement of the products or criticism of similar ones not mentioned, but are used herein for convenience only. Mention of a proprietary product does not constitute a guarantee or warranty of the product by the authors.

CONTENTS

Title	Page	Title	Page
Publication Order Information	2	Plant Growth Retardants Used in Turfgrass Management	95
Poison Control Center Information	3	Herbicide and PGR Common and Trade Names	100
Pesticide Application Record Form	4	Activated Charcoal for Pesticide Deactivation	107
Insect Control	5	Vegetation Management and Weed Control in Specialty Turf Areas	109
Disease Control	24	Aquatic Weed Control in Irrigation Water Supplies	123
Nematode Control	52	Tank-Mixing Chemicals	127
Carrier Water Quality Influences Pesticide Stability	58	Pesticide Calibration Formulas and Information	129
Weed Identification and Control	62	Metric System Conversion Factors	133
Managing Herbicide Resistant Weeds	93		

South Carolina Cooperative Extension Service, Clemson University
www.clemson.edu/turfornamental/

CLEMSON UNIVERSITY TURFGRASS PUBLICATION ORDER INFORMATION

- ✓ **Diagnosing Turfgrass Problems: A Practical Guide**
- ✓ **More Turfgrass and Related Weeds: Beyond the Color Atlas**
- ✓ **Designing and Maintaining Bermudagrass Sports Fields in the United States, 2nd edition - EC 698**
- ✓ **Weeds of Southern Turfgrasses - EB 150**
- ✓ **Diseases of Turfgrasses in the Southeast - EB 146**
- ✓ **Pest Management Handbook (vol. 2), Turfgrass and Ornamentals - EC 695**
- ✓ **Sod Production in the Southern United States - EC 702**
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Other Turfgrass Publications

✓ **Common Turfgrass Weeds**	84 slide set with narrative of the most common weeds in golf courses, home lawns, sports fields, & roadsides.
✓ **Sports Field Construction**	70 slide set with narrative on designing, constructing, and maintaining all levels of sports fields. Both are available from: CSSA Headquarters Office, Attn: Book Order Dept., 677 South Segoe Road, Madison, WI 53711-1086, http://www.crops.org
✓ **Best Golf Course Management Practices (3rd edition)**	A complete text covering all agronomic practices for managing golf courses with minimum fertilizer and pesticide inputs. Order from www.prenhall.com; Amazon.com; GCSAA.com; or BarnesandNoble.com. 1-800-472-7878. **ISBN 0-13-088359-X.**
✓ **Color Atlas of Turfgrass Weeds (2nd edition)**	A complete text covering all major weeds occurring in Turfgrass and Ornamentals. Included are detailed biology, reproductive means, distribution ranges and control recommendations. **ISBN 1-57504-142-1.**
✓ **Managing Bermudagrass Turf**	A complete text concerning Bermudagrass Turf, especially golf greens. **ISBN 1-57504-163-4.** Order these books from GCSAA.com; Amazon.com; or BarnesandNoble.com.
✓ **Weed Control in Turf and Ornamentals**	A complete text on turf and ornamental herbicides, their chemistry, mode of action, and control of the most important weeds in each. **ISBN 13-978-0-13-159122-6.**

POISON CENTERS

Robert G. Bellinger, PhD
Extension Pesticide Safety Education Program Coordinator

Palmetto Poison Center, College of Pharmacy, University of South Carolina, Columbia, SC 29208

Emergency - anywhere:	**1-800-222-1222**	**Georgia:**	**1-800-282-5846**
Emergency - SC state-wide:	**1-800-922-1117**	**North Carolina:**	**1-800-848-6946**
Emergency - Columbia:	**803-777-1117**		
Business number:	**803-777-7909**		

If victim has collapsed or is not breathing, call 911.

National Pesticide Information Center (NPIC): 1-800-858-7378
For a pesticide chemical emergency or for any pesticide information.
E-mail: npic@ace.orst.edu World Wide Web: http://npic.orst.edu

For small pesticide spills: call the manufacturer (see the product label), or the NPIC at 1-800-858-7378.

PIP- 43 - Pesticide Recordkeeping Requirements for Commercial & Non-commercial Applicators - In South Carolina, commercial and non-commercial pesticide applicators may be required to maintain records on their pesticide applications under more than one regulation. http://www.clemson.edu/extension/pest_ed/pdfs/pipsheets/pip43comm.pdf

PIP- 44 - Pesticide Application Information Disclosure Requirements - In South Carolina, all pesticide applicators are required to maintain records or display information on their pesticide applications, and often, under more than one regulation. http://www.clemson.edu/extension/pest_ed/pdfs/pipsheets/pip44disclos.pdf

PESTICIDE APPLICATION RECORD

Company Name _____ Commercial Applicator _____ License Number_____

Pesticide License Category _____ Trade Name _____ Active Ingredient(s) & Formulation _____

% Active Concentration(s) ____/____/____ Manufacturer _____ Lot No. _____ EPA Registration No._____

Restricted-entry Interval (REI) _____ Safety Equipment Needed/Worn _____

APPLICATION INFORMATION

Application Date: _____ Application Start Time: _____ End Time: _____ Treated Site Location _____

Type of Area Treated _____ Target Pest(s)_____ Total Treated Area _____

Application Rate (e.g, per acre or per 1000 sq. ft.) _____ Amount of Product Mixed: _____ Per _____ Gallons of Water:

Gallons Per Acre (GPA)_____ Additives (Surfactant/Wetting Agent/Crop Oil, etc.) _____Rate _____

WEATHER CONDITIONS

Air Temperature (□F)_____ Relative Humidity (%)_____ Dew Present (Y/N)_____ Initial Wind Velocity (MPH)_____

Wind Direction _____; First Hour_____; Second Hour_____; Third Hour_____; Soil Temperature at 4 inches (^{o}F)_____

Soil Moisture_____ Cloud Cover (%)_____ Rainfall/Irrigation after application (date/time/amount) _____

APPLICATION EQUIPMENT

Method of Application _____ Speed (MPH)_____ Motor Speed (RPM)_____ Nozzle Type_____Number _____

Nozzle Height_____ Spacing _____ Boom Width_____ Spray Pressure (PSI)_____

Nontarget Plant, Animal, or Human Exposure: Yes __ No____ (If yes, identify and list corrective or emergency action taken) _____

Other Comments:

Signature_____ **Date**_____

INSECT CONTROL

Juang-Horng 'JC' Chong
Research and Extension Entomologist

Contrary to most common beliefs, most insects that occur on turfgrass are not pests. Some, such as parasitic wasps and ground beetles, are in fact beneficial insects that feed on the pests and reduce pest population and damage. Therefore, it is important to identify insects found on turfgrass correctly. An effective integrated pest management (IPM) program takes into consideration the biology, ecology, environment impacts, and all available treatment options. An IPM system is not difficult to adopt. Unbeknown to most turfgrass professionals, they are already utilizing some of these elements in making pest management decisions.

Insecticide efficacy can be reduced by many environmental and biological factors. Water pH outside the suitable range can quickly degrade insecticides. Some insecticides may persist longer in clay than in sandy loam. Some insecticides may need irrigation after application to penetrate the soil and kill the insects that live underground. Insects may also develop resistance to one group of insecticides if the same group is applied to the same insect population repeatedly. In order to delay the development of insecticide resistance, avoid using insecticides from same mode of action or IRAC group number repeatedly. To assist in the decision to rotate insecticides, an IRAC table is included in this guide.

Ants (nuisance ants and red imported fire ants): A large number of ant mounds can interfere with the play on the greens. RIFA is also a medical concern because of their stings.
Monitoring: The small mounds made by the nuisance ants on the greens and the large mounds made by the RIFA along the periphery are the tell-tale signs.
Treatment: Most ants can be treated by one of the three methods: individual mound treatment, broadcast granules of baits or long-residual toxicants, and a combination of the two methods.

Billbug: Adults feed on the leaf blades and deposit eggs in the stem. The larvae, resembles legless white grubs, first bore into the stem and then feed on the rhizomes, roots and crown.
Monitoring: Adults can often be found crawling on pavement in the spring. Larvae can be found by digging into the yellowing turf. Grasses fed by the larvae can be easily pulled out from the ground because the roots are consumed. Fine, whitish, saw dust materials often come out of the hollowed stems.
Treatment: Recent research indicates that management should target both adults and grubs. Apply insecticides in last spring (May) and fall (September) when adults are observed.

Caterpillars (cutworm, fall armyworm and sod webworm): Fall armyworm begins to appear in June while cutworms and sod webworms often in the spring.
Monitoring: Conduct soap flush (1-2 fl oz detergent per gallon water) to determine the species and size. Frequent congregations of birds can sometime indicate caterpillar infestations.
Treatments are most effective against small caterpillars; therefore, it is crucial to determine size through soap flush. Treat when needed. Do not irrigate within 24 hours after application.

Chinch bug: Southern chinch bug is the major pest of St. Augustinegrass, often create yellowing or dead patches in the hot, dry days. Thick thatch often accentuates infestations.
Monitoring: Two floatation methods can be used to monitor chinch bug population: 1) insert a large PVC pipe or cut-out coffee can deep into the turf and pour in tap water, or 2) cut a piece of sod and flood it inside a container with tap water. Chinch bugs will float to the top and can be counted.
Treatment: Established treatment threshold is 25-30 chinch bugs per sq ft. A high volume spray (minimum of 50 gal/acre) will be needed to deliver the chemicals into the thatch for control.

Earthworm: Although usually considered beneficial, earthworm can still interfere with play by pushing a large number of castings onto the greens. No control is recommended.

Mole cricket: Tawny and southern mole crickets create tunnels and expose the grass roots to desiccation. Adult flight occurs in April to June. Egg hatch occurs from June through July.
Monitoring: Check for tunnels. Soap flush (1-2 fl oz lemon scented detergent per gallon water) in areas large numbers of tunnels can capture the mole crickets and determine body sizes.
Treatment: Treatment of young nymphs in June and July is more effective than treatment of adults in spring and larger nymphs in the fall. When contact insecticides are used, irrigate after application can help to push the insecticides into the soil.

White grubs: White grubs feed on the roots of turfgrass. Infested turf turns yellow and wilt. Severe infested turf feels spongy under foot and often fall apart when cut or lifted.
Monitoring: Remove sod from the ground and carefully inspect root zone for the grubs. Treat when more than 7-10 grubs are found in 1 sq ft of sod.
Treatment: Preventive treatment of young white grubs in May to June using long residual insecticides (such as neonicotinoids) is more effective than curative treatment of larger grubs in July and August (using insecticides such as trichlorfon). Because the grubs live deep underground, the insecticides have to be irrigated in after application.

Biology and management information of the above mentioned and other pests of turfgrass are listed in the table.

Common Turf Insecticides Listed by IRAC Classification, Chemical Classes or MOA

IRAC Group	Mode of Action	Chemical Classes	Active Ingredient	Trade Name[1]
1A	Acetylcholine esterase inhibitors	Carbamates	carbaryl	Sevin
			methiocarb	Mesurol
1B		Organophosphates	acephate	Orthene
			chlorpyrifos	Dursban
			trichlorfon	Dylox
2B	GABA-gated chloride channel antagonists	Fipronil	fipronil	Chipco Choice, Chipco TopChoice
3	Sodium channel modulators	Pyrethroids	bifenthrin	Allectus[2], Aloft[2], Onyx, Talstar
			cyfluthrin	Tempo
			cypermethrin	Demon
			deltamethrin	Deltagard
			lambda-cyhalothrin	Lambda, Battle, Demand, Scimitar, Tandem[2]
			permethrin	Astro
4A	Nicotinic acetylcholine receptor agonists/antagonists	Neonicotinoids	clothianidin	Arena, Aloft[2]
			dinotefuran	Zylam
			imidacloprid	Allectus[2], Imidacloprid, Merit, Mallet, etc.
			thiamethoxam	Meridian, Tandem[2]
5	Nicotinic acetylcholine allosteric activator	Spinosyns	spinosad	Conserve, Justice Fire Ant Bait
6	Chloride channel activators	Avermectins	abamectin	Affirm, Varsity Fire Ant Bait
7A	Juvenile hormone mimics	Junevile hormone analogues	s-methoprene	Firestrike[2], Extinguish, Extinguish Plus[2]
7B		Fenoxycarb	fenoxycarb	Award Fire Ant Bait
7C		Pyriproxyfen	pyriproxyfen	Distance Fire Ant Bait
11B1	Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis*	*B.t.* var. *aizawai*	Xentari
11B2			*B.t.* var. *kurstaki*	Biobit, Crymax, Dipel, Juvelin, Lepinox
18A	Ecdysone agonists.molting disruptors	Diacylhydrazines	halofenozide	Mach 2
20	Mitochondrial complex III electron transport inhibitors (Coupling Site II)	Hydramethylnon	hydramethylnon	Amdro Firestrike[2], Extinguish Plus[2], SiegePro
22	Voltage-dependent sodium channel blockers	Indoxacarb	indoxacarb	Advion, Provaunt
		Metaflumizone	metaflumizone	Siesta
28	Ryanodine receptor modulator	Diamides	chlorantraniliprole	Acelypryn
			cyantraniliprole	(To be available in 2014)
un	Unknown MOA	Dicofol	dicofol	Kelthane, Dicofol
uc	Unclassified: Pathogens	Bacteria	*Bacillus popillae*	Milky spore powder
		Nematodes	*Steinernema* and *Heterorhabditis* spp.	Millenium, BioVector, Nemashield
		Fungi	*Beauveria bassiana*	Botanigard, Naturalis

[1]Trade names are provided as examples only. No endorsement of products is intended, nor is criticism of unnamed products implied.

[2]Allectus = imidacloprid + bifenthrin; Aloft = clothianidin + bifenthrin; Tandem = thiamethoxam + lambda-cyhalothrin; Amdro Firestrike and Extinguished Plus = s-methoprene + hydramethylnon.

Pesticide Application Information – While the label is the law, the following sources may be helpful when seeking information regarding specific pesticide products. -Department of Pesticide Regulation (DPR) http://www.clemson.edu/public/regulatory/pesticide_regulation/

-Pesticide Information Page http://www.kellysolutions.com/clemson/pesticides/pesticideindex.asp

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Ants, Nuisance	acephate	Orthene TT&O 75 and 97	1.2 to 1.6 oz/gal, see label	In most cases ants serve as predators of turfgrass pests and competitors to red imported fire ants. Ants become a nuisance when they build up to a high number, invade buildings and equipments, and build mounds that interfere with the smoothness of the greens. Species identification and an understanding of ant biology are critical in deciding where to treat and what to treat with, especially when baits are used. Ants are very susceptible to insecticide treatments, but relief of the problem seldom occurs unless the colony itself is eliminated. Sap-sucking insects (such as aphids, mealybugs, scale insects and leafhoppers) on nearby vegetations or landscape ornamentals should be controlled to reduce their attraction to the honeydew-seeking ants.
	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	
		OnyxPro	0.16 to 0.32 fl oz	
		Talstar EZ Golf , GC Gran, PL	2.3 to 4.6 lbs	
		Talstar GC Flowable, Talstar One	0.25 to 1.0 fl oz	
	carbaryl	Sevin 5 Bait	11 oz	
		Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	2.5 to5.0 lb/acre	Check labels of Sevin products for site restrictions.
		Sevin SL	1.5 to 3 fl oz	
	chlorpyrifos	Dursban 50W	2 lb/acre	Dursban PRO is for uses on golf courses, road medians, and industrial plants sites only. Dursban 50W can also be used on sod farms and seed productions.
		Dursban PRO	1.5 fl oz	
	clothianidin	Arena .25G	1.84 to 3.67 lbs	
		Arena .5G	1.0 to 1.8 lbs	
	clothinidin + bifenthrin	Aloft GC SC, LC SC	11.65 to 23.3 fl oz, see label	Use GC formulation of Aloft for golf course and sod farms. Use LC formulation of Aloft for residential and commercial lawns, parks, recreational areas, and athletic fields.
		Aloft GC G, LC G	80 to 160 lbs, see label	
	cyfluthrin	Tempo (various formulations)	See label	Check label for site restrictions.
	cypermethrin	Demon Max	0.5 fl oz/gal	Demon is for lawn and landscape uses.
		Demon WP	0.33 oz/gal	
	deltamethrin	DeltaGard GC, DeltaGard T&O	0.4 to 0.6 fl oz	DeltaGard is for lawns, recreational areas and athletic fields. Use GC formulation for golf courses and sod farms.
		DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	fenoxycarb (bait)	Award Fire Ant Bait	1 to 1.5 lbs/acre	For fire ants and big-headed ants. Not for use on sod farms and seed productions.
	fipronil	Chipco TopChoice	2 lbs	Broadcast or slit applications. Provide 3 months control. Not for pasture and grazing lands. Check label for buffer zone and yearly application limit requirements.
		Chipco Choice	4.6 oz	
	hydramethylnon (bait)	Amdro Pro, SiegePro	1 to 1.5 lbs/acre	For fire ants, big-headed ants, and harvester ants.
		Maxforce G	1 to 2 lbs	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.7 to 2.9 lbs	Use GC formulation of Allectus on golf courses and sod farms.
		Allectus SC, Allectus GC SC	1.32 to 1.65 fl oz	
	indoxacarb (bait)	Advion Fire Ant Bait	1.5 lb/acre	For fire ants, big-headed ants, and pavement ants.
	lambda-cyhalothrin	Demand EZ	13.6 to 28 ml	Demand and Scimitar for use on lawns, recreational areas and athletic fields. GC formulation also for gold course and sod farm uses.
		Demand G	2 to 3 lbs	
		Demand CS, Scimitar GC and CS	3.4 to 7 ml	
	methoprene + hydramethylnon (bait)	Extinguish Plus	1.5 lbs/acre	For fire ants, native ants, big-headed ants, harvester ants, and Argentine ants.
	permethrin	Astro	0.4 to 0.8 fl oz	Astro is for use on lawns, recreational areas and athletic fields.
	pyriproxyfen (bait)	Distance Fire Ant Bait	1 to 1.5 lbs/acre	For fire ants and big-headed ants.

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Ants, Red Imported Fire	**Mound treatment and Broadcast insecticide**			The Red Imported Fire Ant (RIFA) found in South Carolina is an invasive species. Movement of soil and plant materials is regulated by a federal quarantine. If shipment of soil, sods or plant crops outside of the quarantine area is intended see http://www.aphis.usda.gov/oa/pubs/ifapub.pdf for regulations on the specific treatments required by USDA-APHIS, or consult with the SC Department of Plant Industry. Chemicals for RIFA management can be broken into three categories: Individual mound treatments, broadcast bait treatments and broadcast insecticide treatments. Individual mound treatments (e.g., liquid drenches or granules) are fairly fast acting, but only work to kill the mounds that are directly treated. They are most appropriate for eliminating individual mounds that present a hazard or as clean-up treatments. They are not effective as a management strategy for reducing the RIFA population in an area. Broadcast bait treatments are more effective in reducing the population in a given area. The speed at which the baits reduce mound numbers differs by products. Some are slower acting and no results will be noticed for three or four weeks. More recently introduced products act faster. Baits will most likely need to be applied in the spring and fall. Most baits are applied at a rate of 1 to 1.5 lbs per acre. The key to success with RIFA bait products is to broadcast the material when the ants are foraging since most of the products breakdown quickly in sunlight and water. Foraging activity is regulated by surface soil temperatures. RIFA forage when soil temperature reaches above 65°F. The best way to determine if ants are actively foraging is to place a small amount of test bait in the area to be treated. If RIFA hit the bait within 30 minutes then it is a good time to use the baits. Broadcast insecticide treatments are recommended for high use areas with zero tolerance for RIFA. Most of these applications are relatively expensive and therefore cost prohibitive in large areas. The advantage of the broadcast granular products is the high level of control that can be achieved. They are also relatively easy to use and can go out at any time of the year. Most of the products can give up to twelve months of control. To achieve good control, the product should be applied evenly and thoroughly to cover all areas to be treated. Combinations of IMT, bait, and/or granular broadcast treatments based upon the needs of the site are likely to produce better results than the use of a single chemical or strategy alone. The 'two-step' program is a combination of both broadcast bait and individual mound treatments, which is suitable for large and medium-sized area at a moderate cost. First step involves broadcasting slow-acting baits in the spring and/or fall, when the RIFA is actively foraging. Then individual RIFA mounds can be treated individually with a fast-acting contact insecticide in step two. This shortcoming of this treatment program is the relatively long time required before an overall reduction in the RIFA population and mounds will be observed. Check label of individual insecticide for information on site uses, application method, yearly application limit and buffer zone restrictions.
	acephate	Orthene TT&O 75	Drench: 0.2 oz/gal/mound Dry: 1-2 teaspoons/mound	
		Orthene TT&O 97	Drench: 0.15 oz/gal/mound	
	bifenthrin[2]	Onyx Pro	Broadcast: 0.16 to 0.32 fl oz	
		Talstar EZ Golf, Talstar GC Gran	Broadcast: 2.3 to 4.6 lbs	
		Talstar GC Flowable, Talstar One	Broadcast: 0.5 to 1.0 fl oz Drench: 1 teaspoon/gal/mound	
		Talstar F	Broadcast: 1.0 fl oz Drench: 1 teaspoon/gal/mound	
	carbaryl	Sevin 10G	Broadcast: 1 to 1.9 oz/mound	
	chlorpyrifos	Dursban 50W	Broadcast: 2 lbs/acre Sod Broadcast: 16 lbs/acre Drench: 0.05 lb/gal/mound	
		Dursban PRO	Broadcast: 1.5 fl oz Drench: 0.5 fl oz/gal/mound	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	Broadcast: 0.27 fl oz	
		Tempo 20 WP, Tempo Ultra WP	Broadcast: 10 grams	
		Tempo 20 WP GC, Power Pak	1 packet/7,800 sq. ft.	
		Tempo 20 WSP	1 packet/5,000 sq. ft.	
	deltamethrin	DeltaGard GC, DeltaGard T&O	Drench: 1.5 fl oz/gal/mound	
		DeltaGard G, DeltaGard GC Gran	Broadcast: 2 to 3 lbs	
	fipronil	Chipco TopChoice	Broadcast: 2 lbs	
		Chipco Choice	Broadcast: 4.6 oz	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	Broadcast: 2.9 to 5.7 lbs Dry: 0.5 cup/mound	
		Allectus SC, Allectus GC SC	Broadcast: 1.32 to 1.65 fl oz SC Drench: 1/3 fl oz/gal/mound GC Drench: 2/3 fl oz/gal/mound	
	lambda-cyhalothrin	Demand EZ	Broadcast: 13.6 to 28 ml	
		Demand CS, Scimitar CS	Broadcast: 3.4 to 7 ml	
	permethrin	Astro	Broadcast: 0.4 to 0.8 fl oz	
	spinosad	Conserve SC	Drench: 0.1 fl oz/gal/mound	
	thiamethoxam	Meridian 25WG	Drench: 1 to 3 oz/100 gal 2-3 gal//mound	
	thiamethoxam + lambda-cyhalothrin	Tandem	Broadcast: 14-28 fl oz/acre	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Ants, Red Imported Fire	**Broadcast baits**			
	abamectin	Varsity Fire Ant Bait	Broadcast: 1 lb/acre Mound: 5 to 7 tbsp/mound	Many baits also control other nuisance ant, such as harvester ants and big-headed ants. Check label for specific instructions.
	fenoxycarb	Award Fire Ant Bait	Broadcast: 1 to 1.5 lbs/acre Mound: 1 to 3 tbsp/mound	
	fipronil	Maxforce FC	Broadcast: 1.5 to 5 lbs/acre Mound: 2 to 5 tbsp/mound	Do not exceed 4 applications per year.
	hydramethylnon	Amdro Pro Fire Ant Bait SiegePro Fire Ant Bait Maxforce G	Broadcast: 1 to 1.5 lbs/acre Mound: 2 to 5 tbsp/mound Broadcast: 1 to 2 lbs/acre Mound: 2 to 5 tbsp/mound	
	indoxacarb	Advion Fire Ant Bait	Broadcast: 1.5 lb/acre Mound: 4 tablespoons/mound	Not for use on sod farms. Do not exceed 4 applications per year.
	methoprene	Extinguish	Broadcast: 1 to 1.5 lbs/acre Mound: 3 to 5 tbsp/mound	Mix with other baits.
	metaflumizone	Siesta	Mound: 1-2 oz.mound Broadcast: 1-1.5 lbs/acre	
	methoprene + hydramethylnon	Extinguish Plus	Broadcast: 1.5 lbs/acre Mound: 2 to 5 tbsp/mound	
	pyriproxyfen	Distance Fire Ant Bait	Broadcast: 1 to 1.5 lbs/acre Mound: 1 to 4 tbsp/mound	
	spinosad	Justice Fire Ant Bait	Broadcast: 2.5 to 5 lbs/acre Mound: 4-6 tbsp/mound	
Billbugs (adults)	bifenthrin[2]	Onyx, OnyxPro	0.07 to 0.16 fl oz, see labels	Billbug adults and larvae feed on the roots and stems of various turfgrasses, with bermudagrass, zoysiagrass and seashore paspalum being the most susceptible. Symptoms are often misdiagnosed as drought stress or disease. Symptoms first appear as scattered dead stems and later enlarge to small patch turning from yellow to brown. Straw-color dead grasses are easily pulled out with the hollowed stem break away from the crown. Fine, sawdust-like frass can be seen at the base. The affected turf, which appears drought-stressed, does not recover with watering. Damage usually shows up in mid- to late-summer (worst in August) during extended drought period. Soil remains firm, not spongy underfoot as with white grub or mole cricket infestations. Adults can be forced from the grass with a detergent or captured with a pitfall trap. Adults can be found from March to November in SC; the peak activity occurs in May and September. Treat for grubs soon after adult peak activity. Detection and treatment for larvae are similar to white grubs. Treat when adults and/or larvae are found and damage is apparent. Most materials, particularly those against the grubs, should be watered-in with 2-inch immediately after application. Check label of individual insecticide for information on site uses, application method, yearly application limit and buffer zone restrictions.
		Talstar EZ Golf, GC Gran, PL	1.15 to 2.3 lbs	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
	chlorpyrifos	Dursban 50W	2 to 4 lbs/acre	
		Dursban PRO	1.5 fl oz	
	clothianidin + bifenthrin	Aloft GC SC, LC SC	11.65 to 23.3 fl oz, see label	
		Aloft GC G, LC G	80 to 160 lbs, see label	
	cyfluthrin	Tempo (various SC formulation)	see label	
		Tempo 20 WSP, Power Pak	1 packet/5,000 to 7,800 sq. ft.	
	deltamethrin	DeltaGard GC, DeltaGard T&O	0.6 to 0.9 fl oz	
		DeltaGard GC Gran, DeltaGard G	2 to 3 lbs	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.7 to 2.9 lbs	
		Allectus SC	0.4 to 1.65 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Billbugs (adults)		Allectus GC SC	0.9 to 1.65 fl oz	
	lambda-cyhalothrin	Demand EZ	28 ml	
		Demand G	3 to 4 lbs	
		Demand CS, Scimitar GC and CS	7 ml	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32 to 0.64 fl oz	Labeled for bluegrass billbug.
Billbugs (grubs)	carbaryl	Sevin 80 WSP	10 lb/acre	Begin preventive treatment against larvae soon after the adults become active in the spring (usually in late April and May; monitor with pitfall traps). Larger grubs can also be controlled curatively (although less effectively) in early summer (when the grubs are in the soil) with methods similar to the white grubs.
		Sevin SL	6 fl oz	
	chlorpyrifos	Dursban 50W	2 to 4 lbs/acre	
	chlorantraniliprole	Acelypryn	0.184 to 0.46 fl oz	
		Acelepryn granule	1.15 to 2.3 lb	
	clothianidin	Arena .25G	1.84 to 3.67 lbs	
		Arena .5G	1.0 to 1.8 lbs	
		Arena 50 WDG	6.4 to 12.8 oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	
		Aloft GC G	80 to 132 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
		Aloft LC G	80 to 160 lbs	
	dinotefuran	Zylam 20SG	1 oz	
	imidacloprid[2]	Merit 0.5 G	1.4 to1.8 lbs	0.5G is not for use on sod farms.
		Merit 2 F	0.46 to 0.6 fl oz	
		Merit 75 WP	3 to 4 teaspoons	
		Merit WSP	1 packet/8,250-11,000 sq. ft.	1 packet = 1.6 oz
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.7 to 2.9 lbs	
		Allectus SC	0.4 to 1.65 fl oz	
		Allectus GC SC	0.9 to 1.65 fl oz	
	halofenozide	Mach 2 2SC	2.9 fl oz	2SC is not for uses in residential lawns.
		Mach 2 1.5G	3 lbs	Allow 7 days before treatment and harvest of sods when using Mach 2.
	thiamethoxam	Meridian 0.33G	1.42 to 1.88 lbs	
		Meridian 25WG	0.3 to 0.39 oz	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32-0.64 fl oz	
	trichlorfon	Dylox 6.2G	3 lbs	Dylox is not for uses in sod farms, seed productions and research.
		Dylox 80 T&O	3.75 fl oz/100 gal	
Caterpillars	acephate	Orthene TT&O 75, 97	see label	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Caterpillars (Armyworms, Cutworms, Sod Webworms)	*Bacillus thuringiensis* (*Bt*)	Biobit, Crymax, Deliver, Dipel, Javelin, Lepinox, XenTari	0.5 to 3 lbs/acre, see label	Fall armyworm, cutworm and sod webworm are the major pest caterpillar species of turfgrass. All lawn caterpillars feed on grass blades. True armyworms feed in groups, creating circular patches of bare grounds. Fall armyworms are less gregarious, so the damage often occurs as thinning of grasses in a broad area. Fall armyworm migrates from FL and southern GA each year. Damage begins to appear in June but at this time the caterpillars have become too big and difficult to control. Symptoms of care grounds often appear near building, trees, posts, poles and other erected structures as adult moths often lay eggs on these structures. Cutworms dig a burrow in the thatch or soil and eat the grass around the burrow at night, resulting in small patches of dead greens and sunken areas; thus reducing the smoothness and uniformity of putting surface. Frequent mowing and clipping removal help to reduce population but not enough to achieve control. There are several generations of sod webworm in a year. The damage begins to appear in spring and becomes progressively severe with the season. Damage begins as general thinning, followed by small patches of brown, closely-cropped grass; later coalesces into large irregular patches with severe infestations. Adult sod webworm or lawn moths, which have characteristic snout-like projections in front of their heads, are active flyers over turfgrass in the evening. The presence of birds feeding on the caterpillar should also be an indicator. All caterpillar species can be monitored with detergent flush. Treated areas (with most contact insecticides) **should not be irrigated within 24 hours** of treatment so that the caterpillars will come in contact with the residues. Caterpillars are often attacked by natural enemies; therefore, conserve these natural enemies with less frequent sprays or compatible insecticides whenever possible. Use higher rates of Sevin for cutworm control. Zylam is registered for use on cutworm and sod webworm. Only effective against small caterpillars. Mach 2 for use in commercial sites only. Both formulations are more effective against younger caterpillars. They are preventive rather than curative in nature. Merit is for cutworm only. Must be applied against early stages. May only achieve suppression of the population. 1 packet = 1.6 oz.
	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	
		OnyxPro	0.05 to 0.08 fl oz	
		Talstar EZ Golf , GC Gran, PL	1.15 lbs	
		Talstar GC Flowable, One, F	0.18 to 0.25 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 oz, see label	
		Sevin 80 WSP	2.5 to10 lb/acre, see label	
		Sevin SL	1.5 to 6 fl oz, see label	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	chlorantraniliprole	Acelypryn	0.046 to 0.092 fl oz	
		Acelepryn granule	1.15 to 2.3 lbs	
	clothianidin	Arena .25G	1.84 to 3.67 lbs	
		Arena .5G	1.0 to 1.8 lbs	
		Arena 50 WDG	12.8 oz	
	clothianidin + bifenthrin	Aloft GC SC, LC SC	11.65 to 23.3 fl oz; see label	
		Aloft GC G	80 to 132 lbs	
		Aloft LC G	80 to 160 lbs	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.135 to 0.27 fl oz	
		Tempo 20 WP, Tempo Ultra WP	5 to10 grams	
		Tempo 20 WP GC, Power Pak	1 packet/7,500-11,000 sq. ft.	
		Tempo 20 WSP	1 packet/5,000-10,000 sq. ft.	
	deltamethrin	DeltaGard T&O, DeltaGard GC	0.2 to 0.4 fl oz	
		DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	dinotefuran	Zylam 20SG	1 oz	
	nametodes[2]	Various products	See label	
	halofenozide	Mach 2 2SC	1.5 fl oz	
		Mach 2 1.5G	1.55 lbs	
	imidacloprid[2]	Merit 0.5 G	1.4 to 1.8 lbs	
		Merit 2 F	0.46 to 0.6 fl oz	
		Merit 75 WP	3 to 4 teaspoons	
		Merit 75 WSP	1 packet/8,250-11,000 sq. ft.	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.2 to 2.9 lbs	
		Allectus GC SC	0.67 to 1.65 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Caterpillars (Armyworms, Cutworms, and Sod Webworms)		Allectus SC	0.4 to 1.65 fl oz	
	indoxacarb	Provaunt	0.046 to 0.092 oz	Not for use on sod farms.
	lambda-cyhalothrin	Demand EZ	13.6 to 28 ml	
		Demand G	2 to 3 lbs	
		Demand CS, Scimitar GC, CS	3.4 to 7 ml	
	permethrin	Astro	0.4 to 0.8 fl oz	
	spinosad	Conserve SC	0.25 to 1.2 fl oz, see label	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32-0.64 fl oz	
	trichlorfon	Dylox 80 T&O	2.5 to 3.75 fl oz/100 gal	
		Dylox 6.2G	2 lbs	
Chinch Bugs	acephate	Orthene TT&O 75 and 97	0.9 to 2.4 oz; see label	
	Beauveria bassiana	Botanigard	0.5 to 2 qts/100 gal	Chinch bugs are a major problem of St. Augustinegrass. Hot, dry weather, deep thatch, and high fertility favor chinch bug development. Infested turfgrass first appear yellow and stunted. As the infestation progresses, the grass wilt and dead, creating small dead patches which will expand as the infestation continues and the damage worsens.
	bifenthrin[2]	Onyx, OnyxPro	See label	
		Talstar EZ Golf, GC Granular, PL	2.3 to 4.6 lbs	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	Sampling for chinch bugs is conducted using the floating method. Plugs of turf and soil can be placed in a 5-gallon bucket filled with clean water or an open ended cylinder (metal can or PIV pipe) driven into the ground and filled with clean water. Adults and nymphs will float to the surface within 10 minutes. Do not use soapy water. For best result sample along the edge of the damage. If chinch bugs are suspected and floating yields no results, visual examination of the stolens in the thatch layer may yield results.
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	7.5 to 10 lb/acre	
		Sevin SL	4.5 to 6 fl oz	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	Treatments should be applied if 25 to 30 insects are found per square foot. Chinch bugs are often found in the thatch layer. Thus higher volume is critical in delivering the insecticides through the thatch layer and to successful insecticide treatments. See insecticide label for specifics. In general, **use a minimum spray volume of 50 gallons/acre (1.2 gallons/1000 sq. ft.)**.
	chlorantraniliprole	Acelypryn	0.184 to 0.46 fl oz	
		Acelepryn granule	1.15 to 2.3 lbs	
	clothianidin	Arena .25G and .5G	1.5 to 3.67 lbs, see label	
		Arena 50 WDG	12.8 oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	St. Augustinegrass varieties 'Floratam', 'Floralawn' and 'Captiva' are resistant to chinch bugs. Cultural controls include less N, using water insoluble (slow release) N, using a sharp mower blade, mowing at 3" in sun areas, 4" in shaded areas, and controlling thatch. Irrigate with ¾-inch when grass begins to wilt. Minimize the use of atrazine on St. Augustinegrass during summer. Monitor turf regularly. To preserve beneficial arthropods, limit treatment to the damaged area and 5 to 10 feet beyond. Recheck in 2-3 days. Spot treat again, if needed.
		Aloft GC G	80 to 132 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
		Aloft LC G	80 to 160 lbs	
	cyfluthrin	Tempo (various formulations)	See label	
	cypermethrin	Demon Max	0.33 to 0.65 fl oz	Acelypryn provides suppression only.
	deltamethrin	DeltaGard GC, DeltaGard T&O SC	0.6 to 0.9 fl oz	
		DeltaGard G, GC Gran, T&O Gran	2 to 3 lbs	
	dinotefuran	Zylam 20SG	1 oz	Zylam only achieves suppression.
	imidacloprid[2]	Merit 0.5 G	1.8 lbs	Merit only achieves suppression.

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Chinch Bugs		Merit 2 F	0.6 fl oz	
		Merit 75 WP	4 teaspoons	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.7 to 2.9 lbs	
		Allectus SC, Allectus GC SC	1.65 fl oz	
	lambda-cyhalothrin	Demand EZ	56 ml	
		Demand G	3 to 4 lbs	
		Demand CS, Scimitar GC, CS	14 ml	
	permethrin	Astro	0.4 to 0.8 fl oz	
	thiamethoxam	Meridian 0.33G	1.42 to 1.88 lbs	Meridian may only provide suppression.
		Meridian 25WG	0.3 to 0.39 oz	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32 to 0.64 fl oz	
	trichlorfon	Dylox 80 T&O	3.75 fl oz/100 gal	
Chiggers and Ticks	bifenthrin[2]	OnyxPro	0.16 to 0.32 fl oz	Chiggers (red bugs) and ticks may be present in turfgrass areas. Although they do not damage turfgrass, they are however significant health risks. Insecticide treatments are often ineffective. Only DeltaGard, Demand, Demon, Dursban. Scimitar, Sevin and Tempo are labeled at higher rates for chigger control. Keep grass mowed short to discourage chiggers and ticks. Avoid contact by applying repellents and wearing protective clothing.
		Talstar EZ Golf, GC Gran, PL	2.3 to 4.6 lbs	
		Talstar GC Flowable, One, F	0.5 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	2.5 to5 lb/acre	
		Sevin SL	1.5 to 3 fl oz	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.135 to 0.27 fl oz	
		Tempo 20 WP, Tempo Ultra WP	5 to 10 grams	
	cyfluthrin	Tempo 20 WP GC, Power Pak	1 packet/7,500-11,000 sq. ft.	
		Tempo 20 WSP	1 packet/5,000-10,000 sq. ft.	
	deltamethrin	DeltaGard T&O, DeltaGard GC	0.4 to 0.6 fl oz	
		DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	fipronil	Chipco TopChoice	2 lbs	Broadcast application. 1 month control for ticks.
		Chipco Choice	4.6 oz	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	2.9 lbs	
		Allectus GC SC, Allectus SC	1.32 to 1.65 fl oz	
	lambda-cyhalothrin	Demand EZ	13.6 to 28 ml	
		Demand CS, Scimitar GC, CS	3.4 to 7 ml	
	permethrin	Astro	0.4 to 0.8 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
	thiamethoxam + lambda-cyhalothrin	Tandem	0.24 fl oz	0.34 to 1.38 fl oz/1,000 sq ft for ticks.
Earthworms	No control is recommended.			Earthworms are considered beneficial organisms as they help aerate soil and decompose organic materials (such as thatch). However, when a large number of dirt and castings are pushed up to the putting greens, they will interfere with the play. At this time, no control is recommended. Earthworm castings may be managed with applications of saponin-containing products, such as the organic fertilizer Early Bird 3-0-1.
Fleas	acephate	Orthene TT&O 75	1.2 to 2.4 oz	Flea bites result in severe irritation and discomfort for human and pets. Pet owners can prevent infestation by treating the pets with a long-lasting insecticide or with flea collars. When curative treatment is needed, both infested area and pets need to be treated. Mowing the lawn before treatment may increase effectiveness.
		Orthene TT&O 97	0.9 to 1.8 oz	
	bifenthrin	Onyx, OnyxPro	0.07 to 0.32 fl oz, see labels	
		Talstar EZ Golf , GC Gran, PL	2.3 to 4.6 lbs	Use higher rates of bifenthrin for larval control, see label.
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	10 lb/acre	
		Sevin SL	6 fl oz	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.27 fl oz	
		Tempo 20 WP, Tempo Ultra WP	10 grams	
		Tempo 20 WP GC, Power Pak	1 packet/7,800 sq. ft.	
		Tempo 20 WSP	1 packet/5,000 sq. ft.	
	cypermethrin	Demon Max, TC	0.33 to 0.65 fl oz	
	deltamethrin	DeltaGard T&O, DeltaGard GC	0.4 to 0.6 fl oz	
		DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	fipronil	Chipco TopChoice	2 lbs	Broadcast application. 1 month control for fleas.
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	2.9 lbs	
		Allectus SC, Allectus GC SC	0.4 to 1.65 fl oz, see label	
	lambda-cyhalothrin	Demand EZ	28 ml	
		Demand CS, Scimitar GC, CS	3.4 to 7 ml	
	permethrin	Astro	0.4 to 0.8 fl oz	
	spinosad	Conserve SC	1.2 fl oz	Target flea larvae.
	thiamethoxam + lambda-cyhalothrin	Tandem	0.34 to 1.38 fl oz	Perimeter treatment.
Grasshoppers	acephate	Orthene TT&O 75	0.5 oz	Grasshoppers are occasional pests of turfgrass. Usually infestations do not required treatment. During severe infestation, most contact insecticides are very effective.
		Orthene TT&O 97	0.4 oz	
	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Grasshoppers		OnyxPro	0.08 to 0.16 fl oz	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin 5 Bait	11 oz	
		Sevin 10G	1.4 to 1.9 oz	
		Sevin 80 WSP	2.5 to5 lb/acre	
		Sevin SL	1.5 to 3 fl oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	
		Aloft GC G	80 to 132 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
		Aloft LC G	80 to 160 lbs	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.135 to 0.27 fl oz	
		Tempo 20 WP, Tempo Ultra WP	5 to 10 grams	
		Tempo 20 WP GC, Power Pak	1 packet/7,500-11,000 sq. ft.	
	deltamethrin	DeltaGard T&O, DeltaGard GC	0.4 to 0.6 fl oz	
		DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	imidacloprid + bifenthrin	Allectus SC	0.4 to 1.65 fl oz	
		Allectus GC SC	0.9 to 1.65 fl oz	
	indoxacarb	Provaunt	0.275 oz	Not for sod farms.
	lambda-cyhalothrin	Demand EZ	13.6 to 28 ml	
		Demand G	2 to 3 lbs	
		Demand CS, Scimitar GC, CS	3.4 to 7 ml	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.24 fl oz	
Greenbugs (Aphids)	acephate	Orthene TT&O 75	0.5 oz	Greenbug is a species of aphid and is usually a pest of grain crops. In some years, greenbugs will invade turfgrass and suck sap from the grass blades. Population begins to build up in the spring; multiple generations per year. A toxic salivary injected during feeding can cause the leaf areas around the feeding site to turn yellow, then brown and eventually die. Dead grass sometimes show burnt orange coloration. Severe infestation can cause patches of dead grass. The honeydew produced by greenbugs is highly attractive to ants. Infestation is worsened in well fertilized lawns and golf courses. Avoid heavy fertilization. Also allow natural enemies to suppress aphid populations by using less frequent and more compatible insecticides.
		Orthene TT&O 97	0.4 oz	
	bifenthrin[2]	Onyx, Talstar	See label	
	carbaryl	Sevin	See label	
	chlorpyrifos	Dursban	See label	
	clothianidin	Arena .25G	See label	
	clothianidin + bifenthrin	Aloft	See label	
	cyfluthrin	Tempo	See label	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Greenbugs (Aphids)	cypermethrin	Demon	See label	Currently, only Orthene is labeled specifically for greenbug control on golf courses and sod farms (not in landscape). Other contact and systemic insecticides are labeled for control of aphids on landscape ornamentals.
	imidacloprid + bifenthrin	Allectus	See label	
	imidacloprid[2]	Merit	See label	
	lambda-cyhalothrin	Demand, Scimitar	See label	
	permethrin	Astro	See label	
	thiamethoxam	Meridian	See label	
	thiamethoxam + lambda-cyhalothrin	Tandem	See label	
Leafhoppers	acephate	Orthene TT&O 75	1 oz	Leafhoppers can sometime become a significant pest of turfgrass. Leafhoppers overwinter as eggs or adults; with 1-5 generations per year. The adults and nymphs suck sap from grass blades, often causing silvery or whitish flecks or spots. Heavy infestation may cause mottled turf. Leafhopper infestations usually do not require treatment. When necessary, most contact and systemic insecticides are effective. Because of the movement of leafhoppers, repeated applications may be needed. Keep lawns and turf area well maintained. Healthy lawns can outgrow the damage.
		Orthene TT&O 97	0.75 oz	
	bifenthrin[2]	Talstar EZ Golf , GC Gran, PL	1.15 to 2.3 lbs	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	2.5 to 5 lb/acre	
		Sevin SL	1.5 to 3 fl oz	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	
		Aloft GC G	80 to 132 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
		Aloft LC G	80 to 160 lbs	
	deltamethrin	DeltaGard T&O, DeltaGard GC	0.4 to 0.6 fl oz	
		DeltaGard G, T&O Gran, GC Gran	2 to 3 lbs	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	1.7 to 2.9 lbs	
		Allectus GC SC	0.9 to 1.65 fl oz	
		Allectus SC	0.4 to 1.65 fl oz	
	lambda-cyhalothrin	Demand G	2 to 3 lbs	
Rhodesgrass Mealybugs	bifenthrin[2]	Talstar EZ Golf , GC Gran, PL	1.15 to 2.3 lbs	Bermudagrass and St. Augustinegrass are most susceptible to attacks by the Rhodesgrass mealybug. Rhodesgrass mealybugs, similar to aphids and leafhoppers, feed by sucking the sap from leaf blades, stems and crowns. Damaged grass will first wilt, the turn from green to yellow to brown. The damage is especially serious during extended period of drought. When the grass is pulled up, the Rhodesgrass mealybugs are visible as white cottony messed attached to the nodes on grass stems. The mealybugs produced copious amount of honeydew, which is very attractive to ants and wasps. Normally Rhodesgrass mealybugs are not a problem for turfgrass, except in areas where the natural control by predators and parasites are disrupted. Conserve these natural
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin	See label	
	chlorpyrifos	Dursban	See label	
	clothianidin	Arena	See label	
	clothianidin + bifenthrin	Aloft	See label	
	cyfluthrin	Tempo	See label	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Rhodegrass Mealybugs	deltamethrin	DeltaGard T&O, DeltaGard GC	0.4 to 0.6 fl oz	enemies by reducing the frequency of insecticide applications and using more compatible insecticides. Controlling fire ant may help reduce infestations. Full coverage and thorough penetration of infested grass is required to control the Rhodesgrass mealybugs. Therefore, use a high volume and a surfactant for the application. Withhold irrigation for 24 hours after the treatment to allow more contact or systemic activity against the mealybugs. Currently, only Talstar, DeltaGard and Allectus are labeled specifically for mealybug control on turfgrass. Other contact and systemic insecticides are available for control of mealybugs in landscape ornamentals.
		DeltaGard T&O Gran, GC Gran	2 to 3 lbs	
	imidacloprid + bifenthrin	Allectus G, GC Gran	1.7 to 2.9 lbs	
		Allectus SC, Allectus GC SC	0.9 to 1.65 fl oz	
	imidacloprid[2]	Merit	See label	
	lambda-cyhalothrin	Demand, Scimitar	See label	
	permethrin	Astro	See label	
	thiamethoxam	Meridian	See label	
	thiamethoxam + lambda-cyhalothrin	Tandem	See label	
Millipedes **Centipedes** **Pillbugs** **Sowbugs** (Check cross reference table for specific chemicals)	acephate	Orthene TT&O 75	1.6 oz/gal	Millipedes, centipedes, pillbugs and sowbugs are common arthropods in turfgrass areas. They do not damage turfgrass. Centipedes may be important predators of other turfgrass pests. Control of these arthropods is not recommended. When necessary, perimeter treatment with contact insecticides can reduce the frequency of these arthropods invading buildings from the turfgrass areas.
	bifenthrin[2]	Talstar EZ Golf , GC Gran, PL	2.3 to 4.6 lbs	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	2.5 to5.0 lb/acre	
		Sevin SL	1.5 to 3 fl oz	
	chlorpyrifos	Dursban PRO	1.5 fl oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	
		Aloft GC G	80 to 132 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
		Aloft LC G	80 to 160 lbs	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.54 fl oz	
		Tempo 20 WP, Tempo Ultra WP	10 to 20 grams	
		Tempo 20 WP GC, Power Pak	1 packet/93-100 gal, see label	
	cypermethrin	Demon Max, TC	0.5 fl oz	
	deltamethrin	DeltaGard T&O, DeltaGard GC SC	0.4 to 0.6 fl oz	
		DeltaGard G, DeltaGard GC Gran, DeltaGard T&O Gran	2 to 3 lbs	
	imidacloprid + bifenthrin	Allectus G, Allectus GC Gran	2.9-5.7 lbs	Higher rates for pillbug and sowbug control when using granules.
		Allectus SC	0.4 to 1.65 fl oz	
		Allectus GC SC	0.9 to 1.65 fl oz	
	lambda-cyhalothrin	Demand G	2 to 3 lbs	
		Demand EZ	13.6 to 28 ml	
		Demand CS	3.4 to 7 ml	
		Scimitar GC, CS	3.4 to 7 ml	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
	permethrin	Astro	0.4 to 0.8 fl oz	
Mites **Mites (Clover, Bermudagrass, and other eriophyid mites)**	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	Clover mites are a problem in spring and fall. Feeding damage is a silvery discoloration of grass and often near the house foundation. Bermudagrass mites (an eriophyid mite) are a problem on common bermudagrass during hot, dry weather. Feeding causes yellowing and distortion of the grass, often results in a tufted or twisted 'rosette' or 'witch-broom' growth. Another common eriophyid mite pest of warm-season turfgrass is the zoysiagrass mite which causes rosette growth on infested zoysiagrass. Newer, hybrid bermudagrasses and zoysiagrass are resistant to their respective mite pests. Management of bermudagrass mite is especially problematic because no registered products are completely effective against this species. Diazinon has been shown in a study conducted in the 1980s to be the most effective active ingredient. Studies are currently underway to determine the best timing and materials to use for the management of bermudagrass mite. A wetting agent in the spray mixture improves control. Reapply in 10-14 days. Cultural controls include collecting and removing clippings. Reduce mowing height as close as practical if mites are a problem. Do not use Kelthane and Dicofol on residential lawns.
		OnyxPro	0.08 to 0.16 fl oz	
		Talstar GC Flowable, One, F	0.25 to 0.5 fl oz	
	chlorpyrifos	Dursban 50W	2 lbs/acre	
		Dursban PRO	1.5 fl oz	
	cyfluthrin	Tempo 20 WP GC, Power Pak	1 packet/93-100 gal, see label	
	deltamethrin	DeltaGard GC, DeltaGard T&O	0.6 to 0.9 fl oz	
		DeltaGard GC Gran, DeltaGard G, DeltaGard T&O G	2 to 3 lbs	
	dicofol	Kelthane 50 WSP	0.5 to 1 lb/acre	
		Dicofol 4E	2/3 to 1 pints/acre	
	imidacloprid + bifenthrin	Allectus SC	0.4 to 1.65 fl oz	
		Allectus GC SC	0.9 to 1.65 fl oz	
	lambda-cyhalothrin	Demand G	2 to 3 lbs	
		Demand EZ	13.6 to 28 ml	
		Demand CS	3.4 to 7 ml	
		Scimitar GC, CS	3.4 to 7 ml	
Mole Crickets	acephate	Orthene TT&O 75	1.0 to 1.9 oz	Mole cricket adults are present during later winter and early spring. Mating flights occur from April through June. Egg hatch occurs from mid-June through July. The tawny mole cricket is a much more serious problem than the southern mole cricket. Tunneling is the most obvious sign of mole cricket infestation. To detect mole crickets, use a detergent flush consisting of 1 to 2 fl oz liquid detergent per gallon of water. One gallon will flush a 4 sq. ft. area. Treat when mole crickets and damage are present. Treatment in the early spring is probably beneficial because this will reduce the number of adult mole crickets laying eggs. Although small nymphs cause little noticeable damage, their treatment in late June and July is highly recommended. Sprays and granules should be applied during mid to late June. Application of baits and Orthene should be made when damage first appears (early- to mid-July). Insecticides can be applied later in the year (Aug.-Oct.). Soil should be moist at time of treatment. If soil is not moist, it is important to irrigate before applying sprays, granules and baits. After treatment, irrigate sprays or granulars into soil with 2 inch of water, except Orthene and baits. A surfactant may increase the efficacy of Orthene. Apply all pesticides as late in the day as possible. Do not irrigate after application of baits for 2-3 days if possible. Use a higher rate for large nymphs and adult mole cricket control. Cultural controls include not mowing turf shorter than recommended heights. Use a sharp mower blade. Maintain proper fertility and pH levels, as well as irrigation practices.
		Orthene TT&O 97	0.8 to 1.4 oz	
	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	
		OnyxPro	0.16 to 0.32 fl oz	
		Talstar EZ Golf , GC Gran, PL	2.3 to 4.6 lbs	
		Talstar GC Flowable, One, F	0.25 to 1.0 fl oz	
	carbaryl	Sevin 5 Bait	20 to 48 lbs/acre	
	chlorpyrifos	Dursban 50W	4-6 lbs/acre	
	clothianidin	Arena .25G	1.84 to 3.67 lbs	
		Arena .5G	1.5 to 1.8 lbs	
		Arena 50 WDG	12.8 oz	
	clothinidin + bifenthrin	Aloft GC SC, LC SC	11.65 to 23.3 fl oz, see label	
		Aloft GC G, LC G	80 to 160 lbs, see label	
	cyfluthrin	Tempo (various formulations)	See label	
	deltamethrin	DeltaGard GC 5 SC	0.6 to 0.9 fl oz	
		DeltaGard GC Gran, DeltaGard G	2 to 3 lbs	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Mole Crickets	dinotefuran	Zylam 20SG	1 oz	Arena provides only suppression.
	nematodes[2]	Nematac S, various	See label	
	fipronil	Chipco Choice 0.1 G	4.6 to 9.4 oz	Slit application when using Chipco Choice.
		TopChoice	2 lbs	Broadcast application when using Chipco TopChoice. 4 months of control.
	imidacloprid[2]	Merit 0.5 G	1.8 lbs	
		Merit 2 F	0.6 fl oz	
		Merit 75 WP	4 teaspoons	
		Merit 75 WSP	1 packet/8,250 sq. ft.	
	imidacloprid + bifenthrin	Allectus G, Allectus GC	2.9 to 5.7 lbs	
		Allectus SC, Allectus GC SC	1.32 to 3.3 fl oz	
	indoxacarb	Advion Mole Cricket Bait	1.15 to 4.6 lbs/acre	Advion Mole Cricket Bait is not for use on sod farms and seed productions.
		Provanut	0.275 oz	See supplemental label.
	lambda-cyhalothrin	Demand G	3 to 4 lbs	
		Demand EZ	28 to 56 ml	
		Demand CS, Scimitar GC or CS	7 to 14 ml	
	permethrin	Astro	0.4 to 0.8 fl oz	
	thiamethoxam	Meridian 0.33G	1.42 to 1.88 lbs	Meridian provides only suppression.
		Meridian 25WG	0.3 to 0.39 oz	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32 to 0.64 fl oz	
	trichlorfon	Dylox 80 T&O	3.75 fl oz/100 gal.	
		Dylox 6.2G	3 lbs	
Snails and Slugs	iron phosphate	Sluggo	1 lb	Apply late in the evening, especially after rain or irrigation. Reapply when needed. Water infested area thoroughly before application. Do not re-water for 48 hours.
	iron phosphate + spinosad	Sluggo Plus	0.5 lb	
	mesurol	Mesurol 2% Bait	1 lb	
	metaldehyde	Deadline	6.4 oz	
Spittlebugs	acephate	Orthene TT&O 75	1.0 to 1.9 oz	Spittlebugs are increasingly damaging, particularly to centipedegrass. The most common pest species of turfgrass in South Carolina is the two-lined spittlebugs. Adult two-lined spittle bugs have a reddish black with 2 orange or red lines across the wings and a bright red abdomen. Nymphs are found at the base of the grass plant. The nymphs are enclosed individually in white foamy spittle masses. Feeding causes yellowing of the grass. High mowing height and thatch buildup aggravate the problem.
		Orthene TT&O 97	0.9 to 1.8 oz	
	bifenthrin[2]	Onyx	0.07 to 0.15 fl oz	
	carbaryl	Sevin 10G	1.4 to 1.9 lbs	
		Sevin 80 WSP	2.5 to 5.0 lb/acre	There are typically two generations in SC: the first peak of adults occurs in June-July and the second peak in August-September. Overwinter as eggs.
		Sevin SL	1.5 to 3 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
Spittlebugs	clothianidin	Arena .25G	1.84 to 3.67 lbs	Treat when nymphs are present and damage appears. Use a minimum of 50 gallons of water per acre (1.2 gallons/1000 sq. ft.). Mow and irrigate before treatment. Treat also the ornamentals, particularly hollies, for adults. Dethatching , withholding irrigation when nymphs are hatching in May and July, and avoiding planting Japanese hollies near centipedegrass can help reduce infestations.
		Arena .5G	1.0 to 1.8 lbs	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	
		Aloft GC G, LC G	80 to 160 lbs	
		Aloft LC SC	11.65 to 23.3 fl oz	
	cyfluthrin	Tempo 20 WP GC, Power Pak	1 packet/93-100 gal, see label	
	deltamethrin	DeltaGard G, GC Gran, T&O Gran	2 to 3 lbs	
	lambda-cyhalothrin	Demand G	2 to 3 lbs	
Wasps, Bees (Burrowing or Digging)	acephate	Orthene TT&O 75	1.6 oz/gal	Mounds and nests made by soil burrowing wasps and bees can interfere with play and the appearance of the lawns and fields. Treatment should be done in the evening when foraging adults have returned to the nest. Thoroughly spray the entrance to the nest. Burrowing and digging wasps and bees often dig in sandy areas. Improve the grass coverage or re-sodding the thinned areas will help to dissuade the wasps and bees from building a nest. Treatments of landscape ornamentals that are frequented by the honeybees and the native bees, with the hope of killing or dissuading visits by the bees, are strongly discouraged. Lambda-cyhalothrin is registered for outdoor ornamental control of wasps.
		Orthene TT&O 97	1.2 oz/gal	
	bifenthrin[2]	Talstar One	0.25 to 0.5 fl oz	
	chlorpyrifos	Dursban 50W	0.25 to 4 lbs/50 gal, see label	
		Dursban PRO	0.17 to 2.7 fl oz/gal, see label	
	cyfluthrin	Tempo Ultra SC, Tempo Ultra GC	0.54 fl oz/gal	
		Tempo 20 WP, Tempo Ultra WP	20 grams/gal	
	cypermethrin	Demon Max, TC	1 fl oz/gal	
	deltamethrin	DeltaGard G, DeltaGard GC Gran	2 to 3 lbs	
	lambda-cyhalothrin	Demand	See label	
		Scimitar	See label	
	permethrin	Astro	0.4 to 0.8 fl oz	
White Grubs	carbaryl	Sevin 10G	1.9 lbs	May and June beetle, green June beetle, masked chafer, European chafer, black turfgrass ataenius, oriental beetle and Japanese beetle larvae are all grouped under white grubs. Identification of the species is based on the raster (area of spines, hair and bare spaces on the underside of the last abdominal segment). White grubs live in the soil and feed on the grass roots. Infested turf often appears wilt and turns yellow and then brown. Heavily damaged turf feels spongy underfoot. Damaged sod easily fall apart when cut or lifted. Large green June beetle grubs also burrow to the surface at night and cause small dirt mounds on the turf. To detect grubs, remove 1 sq. ft. of sod and carefully inspect the root zone. Pay particular attentions to areas with high feeding and searching activity of black parasitic wasps and other animals. In most cases, if more than 7 grubs are found per sq. ft., treatment is needed. Apply preventive treatment (using neonicotinoids and chlorantraniliprole) in April – June or curative treatment against small grubs in July-August. Most materials should be watered-in immediately (at least 2 inches) after
		Sevin 80 WSP	10 lb/acre	
		Sevin SL	6 fl oz	
	chlorpyrifos	Dursban 50W	2 to 8 lbs/acre	
		Dursban PRO	1.5 fl oz	
	chlorantraniliprole	Acelepryn	0.184 to 0.367 fl oz	
		Acelepryn granule	1.15 to 2.3 lbs	
	clothianidin	Arena .25G	1.84 to 3.67 lbs	
		Arena .5G	1.0 to 1.8 lbs	
		Arena 50 WDG	6.4 to 12.8 oz	
	clothianidin + bifenthrin	Aloft GC SC	11.65 to 19 fl oz	

INSECT PEST CONTROL

Pest	Pesticide Common Name	Pesticide Trade Name and Formulation[1]	Rate / 1,000 sq. ft.	Pest Biology, Symptoms, Cultural Practices, and Comments
White Grubs		Aloft GC G	80 to 132 lbs	application. See label directions.
		Aloft LC SC	11.65 to 23.3 fl oz	Dursban Pro is only for green June beetle grub control.
		Aloft LC G	80 to 160 lbs	
	dinotefuran	Zylam 20SG	1 oz	
	halofenozide	Mach 2 2SC	2.9 fl oz	
		Mach 2 1.5G	3 lbs	
	imidacloprid[2]	Merit 0.5 G	1.4 to 1.8 lbs	
		Merit 2 F	0.4 to 0.6 fl oz	
		Merit 75 WP	3 to 4 teaspoons	
		Merit 75 WSP	1 packet/11,000 sq. ft.	
	imidacloprid + bifenthrin	Allectus G, Allectus GC	2.3 to 2.9 lbs	
		Allectus SC, Allectus GC SC	1.32 to 1.65 fl oz	
	lambda-cyhalothrin	Demand SC, Scimitar SC	7 ml	Demand and Scimitar only provide suppression.
		Demand EZ	28 ml	
		Demand G	3 to 4 lbs	
	thiamethoxam	Meridian 0.33G	1.42 to 1.88 lbs	
		Meridian 25WG	0.3 to 0.39 oz	
	thiamethoxam + lambda-cyhalothrin	Tandem	0.32 to 0.64 fl oz	
	trichlorfon	Dylox 6.2G	3 lbs	
		Dylox 80 T&O	3.75 fl oz/100 gal	

[1]Always check to be sure the formulation that you purchase is labeled for the site and pest you intend to use it for. No endorsement of products is intended, nor is criticism of unnamed products implied. ***Read container label carefully for, use directions, application techniques, irrigation requirements, worker protection information, and precautions.*** **Be sure** the formulation of pesticide you buy and use is labeled for use on turfgrass.

[2]Several trades names available. Check label for active ingredients, formulations and instructions.

Cross reference table of insecticides for major turfgrass pests.

Insecticide (Trade Names)	Armyworms	Mites	Billbugs (Adult)	Billbugs (Larva)	Cutworms	Mole Crickets	Sod Webworm	Chinch Bugs	Spittlebugs	White Grubs
Acephate (Orthene)	yes				yes	yes	yes	yes	yes	
Bacillus thuringiensis (Dipel, etc.)	yes				yes		yes			
bifenthrin (Onyx, Talstar, Allectus, Aloft)	yes	Onyx	yes		yes	yes	yes	yes	yes	
carbaryl (Sevin)	yes		10G	yes	yes	Bait	yes	yes	yes	yes
chlopyrifos (Dursban)	yes	yes	yes	50W	yes	50W	yes	yes		yes
chlorantraniliprole (Acelypryn)	yes			yes	yes		yes	yes		yes
clothianidin (Arena, Aloft)	0.25G		yes	yes	yes	yes	yes	yes	G	yes
clothianidin + bifenthrin (Aloft)	yes		yes	yes	yes	yes	yes	yes	yes	yes
cyfluthin (Tempo)	yes		yes		yes	yes	yes	yes	WSP	
cypermethrin (Demon)						yes		yes		
deltamethrin (DeltaGard)	yes	yes	yes		yes	yes	yes	yes	Granule	
dicofol (Kelthane)		yes								
fipronil (Chipco Choice, Chipco TopChoice)						yes				
halofenozide (Mach2)	yes			yes	yes		yes			yes
imidacloprid (Merit)				yes	yes	yes		yes		yes
imidacloprid + bifenthrin (Allectus)	yes	SC	yes	yes	yes	yes	yes	yes		yes
indoxacarb (Advion, Provaunt)	yes				yes	yes	yes			
lambda-cyhalothrin (Demand, Scimitar)	yes	yes	yes		yes	Yes	yes	yes	Demand G	Demand
permethrin (Astro)	yes					yes	yes	yes		
spinosad (Conserve SC)	yes				yes		yes			
thiamethoxam (Meridian)				yes		yes		yes		yes
thiamethoxam + λ-cyhalothrin (Tandem)	yes		yes	yes	yes	yes	yes	yes		yes
trichlorfon (Dylox)	yes				yes	yes	yes	80 T&O		yes

Cross reference table of insecticides for minor and nuisance turfgrass pests.

Insecticide (Trade Names)	Nuisance Ants	Red Imported Fire Ants	Chiggers	Centipedes	Fleas	Greenbugs	Grasshoppers	Leafhoppers	Mealybugs	Millipedes	Pillbugs	Sowbugs	Snails & Slugs	Ticks	Wasps & Bees
acephate (Orthene)	yes	yes			yes	yes	yes	yes			yes				
bifenthrin (Onyx, Talstar, Allectus, Aloft)	yes	yes		yes	yes		yes	yes	yes	yes	yes	yes		yes	
carbaryl (Sevin)	yes	yes	yes	yes	yes		yes	yes		yes		yes		yes	
chlopyrifos (Dursban)	yes	yes	yes	yes	yes		yes	yes		yes	yes	yes		yes	yes
clothianidin (Arena, Aloft)	yes					yes?			yes?						
clothianidin + bifenthrin (Aloft)	yes	yes					yes	yes			yes	yes			
cyfluthrin (Tempo)	yes	yes	yes	yes	yes	yes?	yes		yes?	yes	yes	yes		yes	yes
cypermethrin (Demon)	yes	yes	yes	yes	yes	yes?			yes?	yes	yes	yes		yes	yes
deltamethrin (DeltaGard)	yes	yes	yes	yes	G		yes	yes	yes		SC	yes		yes	G
fipronil (Chipco Choice, TopChoice)	yes	yes			yes									yes	
Fire ant baits (Amdro, etc.)		yes													
imidacloprid (Merit, Allectus)						yes?			yes?						
imidacloprid + bifenthrin (Allectus)	yes	yes		yes	yes	yes?	SC	yes	yes	yes	yes	yes		yes	
indoxacarb (Advion, Provaunt)	yes	yes					yes								
lambda-cyhalothrin (Demand, Scimitar)	yes	yes	yes	yes	yes	yes?	yes	yes	yes?	yes	yes	yes		yes	
mesurol (Mesurol Bait)													yes		
metaldehyde (Metaldehyde 7.5 G)													yes		
metaflumizone (Siesta)		yes													
permethrin (Astro)	yes	yes		yes		yes?			yes?	yes	yes	yes		yes	yes
spinosad (Conserve)					yes										
thiamethoxam (Meridian)		yes				yes?			yes?						
thiamethoxam + λ-cyhalothrin (Tandem)		yes	yes		yes?	yes?	yes	yes?	yes?						yes?

DISEASE CONTROL

S. Bruce Martin
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Diseases are primary limiting factors to the successful culture of cool and warm season turfgrasses in South Carolina. The wide range of microclimates in the state allow culture of a wide variety of turfgrasses, but frequently the humid conditions and temperature extremes promote many diseases. Fortunately, grasses receiving proper cultural practices including proper irrigation, mowing, and fertilizing are less likely to develop diseases and are not as likely to be seriously damaged if a disease occurs. By enhancing plant vigor, diseases will be minimized and the need for the use of costly fungicides will be reduced. If used, alternate between classes of fungicides to prevent development of fungicide-resistant pathogens. NOTE: Products containing chlorothalonil, iprodione and vinclozolin are not labeled for use on home lawns and products containing thiophanate methyl are limited in their use on home lawns.

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Algae (various species; primarily blue-green algae or cyanobacteria) All grasses Most prevalent on putting greens & other turf mowed excessively low.	Turf areas in partially shaded, damp locations become weak and begin to thin. Traffic and close-mowing enhance potential for algae development. Long-term overcast, rainy weather periods encourage algae on putting greens. These algae are commonly green or brown in color and can be sheet-like, leaf-like, or cushion-like in appearance. Due to their high water content, algae are often quite slippery. Algae growth may become so prolific that they cover turf plants and inhibit water penetration. Improve air circulation and light exposure. Improve drainage and reduce irrigation frequency and amount. Reduce freely available nitrogen at site. On putting greens, verticut lightly, aerify, and/or topdress to disrupt and dry algal mats. Best curative results are with 5 gal water per 1,000 sq.ft. applied for 3 consecutive weeks when air temps. are at least 85 F.	Daconil Action	chlorothalonil + acylbenzolar-S-methyl 6.112 F	2-5.4	7-14
		Daconil Weather Stik	chlorothalonil 6F	2-3.6	7-14 preventive
				4-5.5	14 curative
		Daconil Zn	chlorothalonil 4.16 F	3-6	7-14 preventive
				6-11	7-14 curative
		Daconil Ultrex, Chorothalonil DF	chlorothalonil 82.5%WDG, DF	1.8-3.2 3.6-5	7-14 preventive 14 curative
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	10-14
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	2-5.76	7-14
		Disarm C	chlorothalonil + fluoxastrobin 4.25 SC	3-5.4	7-14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
		Secure	fluazinam 4.17 SC	0.5	14
		Xzemplar	fluxapyroxad 2.47SC	0.21-0.26	14-28
		Fore, Dithane, Pentathlon, others	mancozeb 80WP	6.0	7-14
		Protect DF, others	mancozeb 75DF	6.0	7
		Fore F, others	mancozeb 4LF	9.6	7-14
		Junction	mancozeb + copper hydroxide 60DF	4-8	7-14
		Kocide	copper hydroxide 53.8%	16 oz in 5 gal water	variable
		Maneb plus Zinc	maneb (37%)+ zinc F	9.6	7-14
		note: chlorothalonil formulations have maximum use rates in effect that depends on site - see current labels for details. ***note:*** Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details. ***note***: fungicides are most effective when used preventative. Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.			
Anthracnose leaf blight and **Anthracnose basal**	The causal fungus can infect leaves, sheaths, and tillers. In creeping bentgrass and *Poa annua*,	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2	14-28
		Heritage G	azooxystrobin 0.31G	2-4 lb	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
rot (*Colletotrichum cereale)*	stolons and crowns also may be rotted (anthracnose basal rot). Leaf infection appears as reddish-brown to brown lesions that are often surrounded by a yellow halo. Lesion size may span the blade width and often one lesion will cause complete yellowing of a blade. Tiller infection results in stem girdling and the subsequent appearance of small, yellow patches of turf. The causal fungus can sometimes be observed with a hand lens. It will appear as dark, cushion-like reproductive structures (acervuli) with black spines (setae) extending from the margin of the cushion. Plants with anthracnose basal rot may have deep-seated infections that are not readily diagnosed with only a hand lens. Avoid stressed turf caused by consistent low mowing and rolling of greens, other pests, fertility imbalances, or moisture extremes. Thatch removal will be helpful. In bentgrass greens, manage localized dry spots to prevent anthracnose basal rot from developing.	Briskway	azoxystrobin + difenoconazole 1.67 SC	0.3-0.725	14
Anthracnose leaf blight and **Anthracnose basal rot** (*Colletotrichum cereale)* Creeping bentgrass and Annual Bluegrass primarily		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-2.5 lb	14
		Daconil Action	chlorothalonil + acylbenzolar-S-methyl 6.112 F	3-5.4	7-14
		Daconil Zn	chlorothalonil 4.16F	4.3-5.1	7-14 pre-disease
				>5.1-7.9	14 post-disease
		Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6 F	3-3.6	7-14 pre-disease
				>3.6-5.5	14 pre-disease
		Daconil Ultrex, Chlorothalonil DF	chlorothalonil 82.5% WDG, DF	2.7-3.2	7-14 pre-disease
				>3.2-5	14 post-disease
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	7-21
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-6	14-28
			chlorothalonil + potassium phosphite 5.27 SC	8	14
		Headway	chlorothalonil + propiconazole 4.3 SC	4.5-8.5	14
		Instrata	chlorothalonil + propiconazole +fludioxonil 3.6 SC	2.75-6	14-28
		Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3 SC	3-6	14-21
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
		Rubigan AS	fenarimol AS	1.75-3.5	30
		Secure	fluazinam 4.17 SC	0.5	14
		Medallion	fludioxonil 50WP	0.25-0.5	14
		Medallion	fludioxonil 1.04 SC	1-2	14
		Disarm	fluoxastrobin 4SC	0.18-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Systar	flutolanil + thiophanate methyl 80WDG	2-3	14-30
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		26/36	iprodione + thiophanate methyl 3.8F	2-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	5-7	14-21
		Duosan	mancozeb + thiophanate methyl	3	5-14
		Tourney	metconazole 50WDG	0.28-0.37	14-21
		Eagle	myclobutanil 20 EW	1.2	14-21
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3 ME	1-2	14-28
		Insignia	pyraclostrobin 20 WDG	0.5-0.9	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28G	0.55-1.11	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		3336	thiophanate methyl 50WSB	1-2	10-14
		3336F	thiophanate methyl 46%F	1-2	10-14
		3336	thiophanate-methyl 41%F	2-8 fl	7-14
		3336	thiophanate methyl 50WP	2-8	7-14
		Bayleton	triadimefon 50 WSP, 41.7 Flo	1.0	30
		Compass	trifloxystrobin 50WDG	0.15-0.25	14-21
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Trinity	triticonazole 1.7SC	0.5-1	14-28
		Triton	triticonazole 70WDG	0.15-0.225	14-28
		Triton Flo	triticonazole 3F	0.41-1.1	14-28
Brown Ring Patch (*Rhizoctonia circinata* var. *circinata*)	Affecting *Poa annua* or *Poa trivialis* overseedings during late spring/ early fall mild weather conditions. Symptoms resemble Yellow Patch, but the causal agent is more closely related to *R. zeae* and *R.oryzae* than to *R. cerealis*. Yellow patches or rings of affected turf occur and may be somewhat depressed at the margins. Infections occur on leaf sheaths in the crown region, with no leaf lesions.	Heritage	azoyxystrobin 50%WG	0.2-0.4	14-28
		Heritage TL	azoyxystrobin 0.8TL	1-2	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.3-0.725	14-28
		Heritage G	azoyxystrobin 0.31 G	2-4 lb	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
		Secure	fluazinam 4.17 SC	0.5	14
		Medallion	fludioxonil 50%WP	0.25-0.5	7-14
		Medallion	fludioxonil 1.04 SC	1-2	14
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Tourney	metconazole 50WDG	0.37	14-21
		Affirm	polyoxin 11.3%WDG	0.88 oz	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Insignia Intrinsic	pyraclostrobin 2.08SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WDG	1.11	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81 G	3.0 lb	28
		Torque	tebuconazole 3.6F	0.6	28
		Trinity	triticonazole 1.7SC	1-2	14-28
		Triton Flo	triticonazole 3F	0.5-1.1	14-28
Brown Patch, Rhizoctonia Blight (*Rhizoctonia solani)* bluegrass creeping bentgrass fescues ryegrass	Grass is killed in circular to irregular areas that may expand to several feet in diameter. In close-cut cool season grasses, a darkened "smoke ring" border may be apparent. Brown patch in cool season grasses occurs during humid weather at >75^{o}F. High N,	Heritage	azoxystrobin 50%WG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8 TL	1-2	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.3-0.725	14-28
		Heritage G	azoxystrobin 0.31G	2-4 lb	14-28
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Terraneb 65WP	chloroneb 65WP	3-4	7-10

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Brown Patch, Rhizoctonia Blight (*Rhizoctonia solani)*	thatch buildup, and excessive moisture favor disease. Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch ***note:*** chlorothalonil formulations have new maximum use rates that depend on site - see new labels for details ***note:*** Fungicides containing copper hydroxide may be phytotoxic; read label carefully & use precautions.	Terraneb SP	chloroneb 2.9F	5-7	7-10
		Daconil Action	chlorothalonil + acylbenzolar-S-methyl 6.112 F	2-5.4	7-14
		Daconil Weather Stik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	2-3.6	7-14 pre-disease
				4-5.5	14 post-disease
		Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil 4.17F	2.9-5.1	7-14 pre-disease
				5.8-7.9	14 post-disease
		Daconil Ultrex, Chlorothalonil DF	chlorothalonil 82.5% WG,DF	1.8-3.2	7-14 pre-disease
				3.6-5	14 post-disease
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
			chlorothalonil + fenarimol F	3-6	7-10
		Disarm C	chlorothalonil + fluoxastrobin 4.25 SC	1.5-5.9	14-28
		Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75-8	7-14
		Concert	chlorothalonil + propiconazole 4.3SC	3-8.5	7-28
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	21-28
		Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3 SC	3-6	14-21
		Rubigan AS	fenarimol 11.6% AS	1.5	7-14
		Secure	fluazinam 4.17 SC	0.5	14
		Medallion	fludioxonil 50%WP	0.25 -0.5	7-14
		Medallion	fludioxonil 1.04 SC	1-2	14
		Disarm	fluoxastrobin 4SC	0.09-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	1.2-4.6lb	14-28
		Prostar	flutolanil 70%WP, WDG	1.5-3	14-21
		Systar	flutolanil + thiophanate methyl	2-3	14-21
		Xzemplar	fluxapyroxad 2.47 SC	0.21-0.28	14-21
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26019	iprodione 50%WP	1.5-2	14-28
		Chipco 26GT, Iprodione Pro, others	iprodione 2SC	3-4	14-28
		26/36	iprodione + thiophanate methyl 3.8F	2-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
		Fore, Dithane, Pentathlon, others	mancozeb 80%WP	4	7-14
		Protect DF, others	mancozeb 75%DF	4	7-14
		Junction	mancozeb + copper hydroxide 60DF	2-4	7
		Maneb plus Zinc	maneb (37%)+ zinc F	4.8	7-14
		Tourney	metconazole 50WDG	0.28-0.37	14-21
		Eagle, Myclobutanil 20EW	myclobutanil 20 EW	1.2	14
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3ME	1-2	14-21

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Insignia	pyraclostrobin 20 WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28G	0.55-1.1	14-28
		Pillar G	pyraclostrobin + trtitonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methyl 50WSB	2	5-14
		3336F	thiophanate methyl 46%F	1-2	5-14
		3336	thiophanate methyl 50%WP	2-4	7-14
		3336F	thiophanate methyl 41%F	2-4	7-14
		Spotrete	thiram 4F	3.75-7.5	3-10
		Bayleton	triadimefon 50%WSP, 4.15F	0.5-1.0	15-30
		Compass	trifloxystrobin 50%WDG	0.1-0.25	14-21
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Triton	triticonazole 70WDG	0.15-0.3	14-28
		Triton Flo	triticonazole 3F	0.41-1.1	14-28
		Trinity	triticonazole 1.7SC	0.75-2.0	14-28
		Curalan	vinclozolin 50 WG or DF	1.0	14-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Cercospora Leaf Spot (*Cercospora fusimaculans*) St. Augustinegrass	Brown to purple leaf spots in patches 2-3" in diameter. In high disease severity, entire leaves will yellow, wither and die. Warm, humid weather favors disease incidence. Confused with gray leaf spot. N may reduce disease. Water deeply only when needed in mornings. 'Bitter-blue' selections are more resistant.	None available. Fungicides used to control other leaf spot diseases will provide suppression.			
Copper Spot (Gloeocercospora sorghi) Creeping bentgrass	Small bronze patches about the size of dollar spot occur in humid but mild temperatures. A minor disease in SC, nevertheless it does occasionally occur Manage moisture so that leaf wetness periods are limited. Limit soluble N fertilization.	Daconil Ultrex	chlorothalonil 82.5 WDG	3.2	7-10
		Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112 F	4-5.4	14
		Chlorothalonil DF	chlorothalonil 82.5 DF	3.2	7-10
		Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	3.7-5	14
		Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil + Zn 4.16F	4-5.5;6-8	14
		Renown	chlorothalonil + azoyxystrobin 5.16SC	5.9	7-14
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	2.5	14
		Concert	chlorothalonil + propiconazole 4.3SC	5.5-8.5	14
		Consyst	chlorothalonil + thiophanate methyl 67WDG	3-8	14
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3-5.76	7-14
		Rubigan AS	fenarimol 1AS	0.75-1.5	14
		Systar	flutolanil + thiophanate methyl 80WDG	2-3	10-28
		26/36	iprodione + thiophanate methyl 3.8F	2-4	14-21

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Protect DF	mancozeb 75DF	4-8	14-21
		Fore, Dithane, others	mancozeb 80WP	4-8	10
		Fore F, others	mancozeb 4LF	7-10	7-14
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Tourney	metconazole 50WDG	0.28-0.37	7-14
		Eagle	myclobutanil 20EW	1.2	14-21
		Torque	tebuconazole 3.6F	0.6	28
		3336, TM 4.5F, others	thiophanate methyl 50WP, 4F, 4.5F	2-4	14
		3336 plus	thiophanate methyl 2F	2-4	14
		TM 85WDG	thiophanate methyl 85WDG	0.67-1.3	14
		3336G	thiophanate methyl 2G	1.5-6 lb	14
		Spotrete	thiram 4F	3.75-7.5	14
		Bayleton	triadimefon 50WSP, 4.15 F	0.5-1	3-10
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Curvularia Blight (Curvularia spp.) Bermudagrass	Usually associated with stressed plants from heat, excess moisture, drought, compaction, or other causes. Alleviate stress conditions that may occur.	3336F	thiophanate methyl 41%F	4-8	7-14
		3336 WP	thiophanate methyl 50WP	4-8	7-14
		26/36	iprodione + trifloxystrobin 2.27 SC	5-7	14
Dead Spot (*Ophiosphaerella agrostis*) Creeping bentgrass, rarely Poa trivialis and bermudagrass greens	Small red or bronze spots develop during late spring or early fall that resemble ball marks. Spots die in the center and become tan, with black pepper-like pseudothecia fruiting bodies developing. May be mistaken for dollar spot initially. Generally a problem on young stands of bentgrass (1-4 yrs age). Fertilize with ammonium sulfate to suppress the disease.	Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Emerald	boscalid 70WG	0.13-0.18	14-28
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
		Medallion	fludioxonil 50% WP	0.3-0.5	14
		Medallion	fludioxonil 1.04 SC	1.15-2	14
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Insignia	pyraclostrobin 20 WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		3336 F, 3336 plus	thiophanate methyl 4F, 2F	4-6	14
		3336	thiophanate methyl 50WP	4-6	14
		3336G	thiophanate methyl 2G	6-9 lb	14
Dollar Spot (*Sclerotinia homoeocarpa*) bahiagrass bermudagrass centipedegrass creeping bentgrass ryegrass rough bluegrass	On fine textured grasses, spots appear 1-2" in diameter. On tall or coarse grasses, patches may reach 5 or more inches in diameter. Often, straw-colored lesions move in from leaf margins or occur as distinct bands across the leaf. Most active during 60-80^{o}F in spring and fall. Moisture from fog, dew, or irrigation initiates disease.	Headway	azoxystrobin (5.73%) + propiconazole 1.4ME	0.75-3.0	7-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.3-0.725	14-21
		Emerald	boscalid 70WDG	0.13-0.18	14-28
		Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112F	1-5.4	7-14
		Daconil WeatherStik, Chlortothalonil 720 SFT, others	chlorothalonil 6F	1-2	7-10 pre-disease
				2-3.6	7-21 pre-disease
				4-5.5	14 post-disease

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
St. Augustinegrass tall fescue zoysiagrasses	Low soil moisture, thatch, low N and K favor disease. Avoid N deficiency. Reduce leaf wetness periods by altering irrigation timing. Avoid thatch buildup. Wipe heavy dew off in mornings. ***note:*** chlorothalonil formulations have maximum use rates in effect that depends on site . ***note:*** Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil 4.16F	1.4-2.9	7-10 pre-disease
				2.9-5.1	7-21 pre-disease
				5.8-7.9	14 post-disease
		Chlorothalonil DF	chlorothalonil 82.5% DF	0.9-1.8	7-10 pre-disease
				1.8-3.2	7-21 pre-disease
				3.6-5	14 post-disease
		Daconil Ultrex	chlorothalonil 82.5 WDG	1.8-3.2	7-10
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	7-14
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-21
		Vitalonil	chlorothalonil + potassium phosphite 5.27 SC	2.8-5.75	7-10
		Concert	chlorothalonil + propiconazole 4.3SC	1.5-3	7-10 pre-disease
				3-5.5	14-21 pre-disease
				5.5-8.5	14-28 post-disease
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-21
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	2-5.76	7-21
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
		Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3 SC	3-8	14-28
		Rubigan AS	fenarimol 1AS	0.75-1.5	10-28
		Secure	fluazinam 4.17 SC	0.5	14
		DisArm	fluoxastrobin 4SC	0.18-0.36	14-21
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-21
		Systar	flutolanil + thiophanate methyl 80WDG	2-3	14-30
		Xzemplar	fluxapyroxad 2.47 SC	0.16-0.26	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26GT, Iprodione Pro, others	iprodione 2F, 2SC	2-4	14-28
		26/36	iprodione + thiophanate methyl 3.8F	1-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
		Protect DF	mancozeb 75DF	6-8	7-14
		Fore, Dithane, Pentathlon, others	mancozeb 80WP	6-8	7-14
		Fore Flo	mancozeb 4LF	10-14	7-14
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Maneb plus Zinc	maneb (37%)+ zinc F	9.6-12.8	7-14
		Tourney	metconazole 50WDG	0.18-0.37	14-21
		Eagle	myclobutanil 20 EW	1.2	14-28
		Banner Maxx	propiconazole 1.3ME	0.5-2	7-28
		Insignia	pyraclostrobin 20WDG	0.9	14 (suppression)
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28(suppression)
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.83-1.1	14-21
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		3336 WP	thiophanate methyl 50WP	2-4	14

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		3336 F, 3336 plus	thiophanate methyl 4F,2F	2-4	14-28
		TM 85WDG	thiophanate methyl 85WDG	0.67-1.3	14
		3336G	thiophanate methyl 2G	1.5-6 lb	14
		Spotrete	thiram 75WDG	2.5-5	7-10
		Bayleton	triadimefon 50WSP, 4.15F	0.25-1	14-30
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Trinity	triticonazole 1.7SC	1-2	14-28
		Triton Flo	triticonazole 3F	0.28-1.1	14-28
		Triton	triticonazole 70WDG	0.15-0.3	14-28
		Curalan	vinclozolin 50WP or DF	1.0	21-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Fairy Ring (*Agrocybe, Chlorophyllum, Lycoperdon, Marasmius, Tricholoma* spp., + other mushroom fungi). All grasses	Irregularly sized circular to semi-circular bands of lush green turf become apparent. Turf within circular area may decline, turn brown and thin. Toxins may be involved, but hydrophobic soil is a major problem. Mushrooms may be associated with the rings. Rings may persist for years. Difficult to control. Plugging or aerating to allow more water and fertilizer to reach the roots may help. Some surfactants have helped water penetration.	Heritage	azoxystrobin 50WDG	0.4	28
		Heritage TL	azoxystrobin 0.8 TL	2	28
		Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	4.5.-5.9	21-28
		Disarm	fluoxastrobin 4SC	0.28-0.36	21-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	28
		Prostar	flutolanil 70WP, 70 WDG	2.2-4.5	21-30
		Systar	flutolanil + thiophanate methyl 80WDG	3-6.12	21-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	28
		Tourney	metconazole 50WDG	0.37	21
		Affirm	polyoxin 11.3%WDG	0.88	7
		Endorse	polyoxin 2.5WP	4	7
		Insignia	pyraclostrobin 20WDG	0.9	28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6 F	0.6	28
		Bayleton	triadimefon 50DF,4.15F	1-2	14-21
		Tartan (2ee SC)	triadimefon + trifloxystrobin	2.0	28
Microdochium Patch and **Pink Snow Mold** (*Microdochium nivale*)	Fusarium Patch: Begins in late fall and early winter in wet, humid weather as small, water-soaked spots of 2 inches up to 8 inches in diameter. Patches may appear wet or slimy. Gray to pinkish colored	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8 TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	10-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Cool season grasses are mostly affected, including bentgrass bluegrasses ryegrasses, and fescues	mycelium may be noticeable in patches. Snow is not required for development of Fusarium Patch. The disease may kill grasses in these patches; frequently mis-diagnosed as cool weather Pythium. Pink Snow Mold: Same causal agent as Fusarium Patch, but the disease occurs under snow cover. Preventive fungicide applications must be made prior to persistent snow cover. Avoid excess nitrogen fertilization, irrigate infrequently but thoroughly, avoiding light frequent irrigations. Protect newly seeded areas that are highly susceptible. Reduce shade and increase air movement around greens. ***note:*** chlorothalonil formulations have new maximum use rates in effect that depends on site. *note:* Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	Renown	chlorothalonil + azoyxystrobin 5.17SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	28
		Concert	chlorothalonil + propiconazole 4.3SC	3-8.5	7-21
		Instrata	chlorothalonil + propiconazole + fludioxanil 3.6SC	2.75-6	10-14
		Consyst	chlorothalonil + thiophanate methyl 67WDG	6-8	Single application
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	10-28
		Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3 SC	7-8	28
		Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112F	5.4	21-28
		Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	2.12-5.5	7-14
		Daconil Zn, Chorothalonil 500 Zn, others	chlorothalonil 4.17F	3-7.9	7-14
		Daconil Ultrex	chlorothalonil 82.5%WDG	1.8-5	7-14
		Chlorothalonil DF	chlorothalonil 82.5 DF	1.8-3.2	7-10
		Rubigan AS	fenarimol 1AS	4-8	1-2 applications
		Secure	fluazinam 4.17 SC	0.5	14
		Medallion	fludioxonil 50%WP	0.25-0.5	14
		Medallion	fludioxonil 1.04 SC	1-2	14
		Disarm	fluoxastrobin 4SC	0.18-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Systar	flutolanil + thiophanate methyl 80WDG	2-3	14-21
		Xzemplar	fluxapyroxad 2.47 SC	0.26	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26GT, iprodione pro, Ipro 2SE, others	iprodione 2F, 2SC	4-8	1-2 applications
		26/36	iprodione + thiophanate methyl 3.8F	1-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	5-7	14-21
		Protect DF	mancozeb 75DF	6-8	2-6 wk
		Fore, Dithane, Penthathlon, others	mancozeb 80WP	6-8	14-42
		Fore Flo	mancozeb 4LF	10-14	14-42
		Junction	mancozeb + copper hydroxide 60DF	2-4	14-42
		Tourney	metconazole 50WDG	0.37-0.44	Late fall
		Eagle	myclobutanil 20 EW	1.2-2.4	Fall/winter
		Maneb + zinc	maneb (37%)+ zinc F	9.6-12.8	14-42
		Junction	mancozeb (15%) + copper hydroxide(46%)	4-8	7-14
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, others	propiconazole 1ME	2-4	Single application
		Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	28
		Torque	tebuconazole 3.6F	0.6	28
		Spotrete F	thiram 4F	3-12	Fall and spring
		Spotrete 75WDG	thiram 75WDG	3-8	Fall and spring
		3336, 3336 plus	thiophanate methyl 4F, 2F, 50WP	2-4	14
		TM 85WDG	thiophanate methyl 85WDG	0.67-1.3	14
		Bayleton	triadimefon 50WSP,4.15F	1-2	60-90
		Compass	trifloxystrobin 50WG	0.2-0.25	10-21
		Tartan	trifloxystrobin+ triadimefon 2SC	2	fall/ early spring
		Armada	trifloxystrobin + triadimefon 50WP	1.2	fall/ early spring
		Trinity	triticonazole 1.7SC	0.5-2	14-28
		Triton	triticonazole 70WDG	0.15-0.3	Late fall
		Triton Flo	triticonazole 3F	0.28-1.1	10-14
		Curalan	vinclozalin 50EG	1	10-21
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Gray Leaf Spot (*Pyricularia grisea*) bahiagrass bermudagrass centipedegrass ryegrass St. Augustinegrass tall fescue	Small brown to ash-colored leaf spots with purple to brown margins. Lesions become covered with the gray, velvety, fungal mycelium of *Pyricularia grisea*. In severe cases leaves appear scorched. Prevalent during rainy, summer months. Mainly on St. Augustinegrass, but recently epidemics have occurred on tall fescue and perennial ryegrass. Avoid excess N. Irrigate deeply in early morning. Reduce traffic. Mostly a problem on newly planted St. Augustinegrass, especially in shade, or atrazine-treated St. Augustinegrass. ***note:*** chlorothalonil formulations have new maximum use rates in effect that depends on site.	Heritage	azoxystrobin 50WG ; no more than 2 sequential treatments	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8 TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-21
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Daconil Action	chlorothalonil +acylbenzolar-s-methyl	2-5.4	7-14
		Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	2-3.6	7-10 pre-disease
				4-5.5	14 post-disease
		Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil 4.16%F	3-51	7-10 pre-disease
				6-8	14 post-disease
		Daconil Ultrex	chlorothalonil 82.5%WDG	1.8-3.2	7-10 pre-disease
				3.6-5	14 post-disease
		Chlorothalonil DF	chlorothalonil 82.5 DF	1.8-3.2	7-10
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	10-14
		TwoSome Flowable Fungicide	chlorothalonil + fenarimol	3	7-10
		Disarm C	chlorothalonil + fluoxastrobin 4.25 SC	3-5.9	14-28
		Vitalonil	chlorothalonil + potassium phosphite 5.27 SC	5.75	7-10
		Concert	chlorothalonil + propiconazole 4.3SC	3-8.5	7-21
		Instrata	chloroothalonil + propiconazole + fludioxanil 3.6SC	2.75-6	10-14
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
		Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3 SC	3-8	14-28
		Medallion	fludioxanil 50WP	0.25-0.50	14

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Medallion	fludioxonil 1.04 SC	1-2	14
		Disarm	fluoxastrobin 4SC	0.18-.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Fore, Dithane, Pentathlon, others	mancozeb 80WP	8	14
		Protect DF, others	mancozeb 75DF	6.4-12.8	7-14
		Fore Flo, others	mancozeb 4LF	9-14	5
		Duosan	mancozeb + thiophanate methyl	3-9	7-14
		Tourney	metconazole 50WG	0.37	14
		Eagle	myclobutanil 20EW	1.2-2.4	14
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, others	propiconazole 1.3ME	1-2	14
		Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methyl 50WP, 4F	4-6	10-14
		3336 plus	thiophanate methyl 2F	4-8	14-28
		TM 85WDG	thiophanate methyl 85WDG	2.35-3.53	14
		Bayleton	triadimefon 50WSP, 4.15 Flo	0.5-1	14
		Compass	trifloxystrobin 50WDG	0.15-0.25	14-21
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
"Helmintho-sporium" Leaf Spot/ Melting Out (*Bipolaris, Drechslera* spp.) bahiagrass bermudagrass bluegrass creeping bentgrass ryegrass St. Augustinegrass zoysiagrassescho	Symptoms include leaf spotting and 'melting-out' phases. Leaves have circular to elongated, purplish or brown spots with straw-colored centers on older lesions. Numerous lesions cause leaves to turn reddish-brown, then yellow, and die. Sheath and crown rot may be present. Ryegrass, bluegrasses (*Poa pratensis* and *P. trivialis*) and bermudagrass are most susceptible. Most prevalent when temperatures range from 68-95^{o}F during mild periods of spring and fall. Maintain a balanced fertility. Irrigate deeply in the mornings. Raise mower height during disease outbreaks. Reduce thatch.	Heritage	azoxystrobin 50WDG	0.2-0.4	14-21
		Heritage TL	azoxystrobin 0.8 TL	1-2	14-21
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-21
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-21
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-21
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-21
		Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112F	2-5.4	7-14
		Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	2	7-10 pre-disease
				2-3.6	7-21 post-disease
				4-5.5	14 post-disease
		Daconil Zn, Chlorthalonil 500 Zn, others	chlorothalonil 4.16F	2.9	7-10 pre-disease
				2.9-5.1	7-21 post-disease
				5.8-7.9	14 post-disease
		Daconil Ultrex	chlorothalonil 82.5% WDG	1.8 -3.2	7-21
				3.2-5	14-21
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	note: chlorothalonil formulations have new maximum use rates in effect that depends on site. *note:* Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-21
		Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75	7-10
		Concert	chlorothalonil + propiconazole 4.25SC	3-8.5	7-21
		Instrata	chlorothalonil + propiconazole +fludioxanil 3.6SC	2.75-6	10-21
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-21
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
		Medallion	fludioxonil 50%WP	0.25-0.5	14-21
		Medallion	fludioxonil 1.04 SC	1-2	14
		Disarm	fluoxastrobin 4SC	0.18-.36	14-21
		Disarm G	fluoxastrobin 0.25 G	2.3-4.6 lb	14-21
		Systar	flutolanil + thiophanate methyl 80WDG	2-3	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26GT, iprodione pro, others	iprodione 2F, 2SC	3-4	14-28
		26/36	iprodione + thiophanate methyl 3.8F	1-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
		Duosan	mancozeb + thiophanate methyl	3	5-14
		Fore, Dithane, Penthathlon, others	mancozeb 80WP	4	7-14
		Protect DF, others	mancozeb 75DF	4	7-14
		Fore Flo, others	mancozeb 4LF	5-14	7-14
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Maneb plus Zinc	maneb (37%)+ zinc F	4.8-6.4	7-14
		Eagle	myclobutanil 20 EW	1.2	14
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, others	propiconazole 1.3ME	1-2	14
		Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		3336	thiophanate methyl 50WP, 4F	4-6	7-14
		3336 plus	thiophanate methyl 2F	4-8	7-14
		3336G	thiophanate methyl 2G	6-9lb	14
		Spotrete	thiram 4F	3.75-7.5	3-10
		Compass	trifloxystrobin 50WDG	0.1-0.25	14-28
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Triton	triticonazole 70WDG	0.15-3.0	14-28
		Triticonazole	triticonazole 1.7SC	0.5-2.0	14-28
		Curalan	vinclozolin 50WP or DF	1-2	12-28

note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Large Patch (brown patch in warm season grasses; **Zoysia patch**, large patch of zoysia) (*Rhizoctonia solani* AG 2, 2 LP) zoysiagrass bermudagrass St. Augustinegrass Centipedegrass Seashore Paspalum	With Large Patch disease of warm season grasses, leaf fascicles pull easily from plant due to rot at leaf base. Initial infections are in the fall, but symptoms are usually most apparent in the spring as grasses emerge from winter dormancy. Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch. Correct compaction and areas of poor drainage	Heritage	azoxystrobin 50WDG	0.4	14-28 (1, 2 or 3 applications in fall
		Heritage TL	azoxystrobin 0.8TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.3-0.725	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Terraneb 65WP	chloroneb 65 WP	5	21-28
		Terraneb SP	chloroneb 2.9F	9	21-28
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-28
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
		Secure	fluazinam 4.17 SC	0.5	14
		Disarm	fluoxastrobin 4SC	0.367	28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
		Prostar	flutolanil 70WP, 70 WDG	2.2	30
		Xzemplar	fluxapyroxad 2.47 SC	0.21-0.26	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26GT, iprodione pro, others	iprodione 2F, 2SC	4	14-21
		26/36	iprodione + thiophanate methyl 3.8F	2-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	4	14-21
		Tourney	metconazole 50WG	0.37	14
		Eagle	myclobutanil 20 EW	2.4	Apply in fall before dormancy, repeat 28 days
		Affirm	polyoxin D 11.3%WDG	0.88	7-14
		Endorse	polyoxin D 2.5WP	4	7-14
		Banner Maxx, others	propiconazole 1.3ME	3-4	1 application in early fall, prior to symptoms
		Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		3336, others	thiophanate methyl 4F, 50WP	2-4	7 to 14
		3336 plus	thiophanate methyl 2F	2-4	7-14
		Systar	thiophanate methyl +flutolanil 80WDG	2-3	14-21
		Trinity	triticonazole 1.7SC	1-2	14-28
		Triton	triticonazole 70WDG	0.15-0.3	14-28
		Triton Flo	triticonazole 3SC	0.55-1.1	14-28
Pink Patch (*Limonomyces*	Mats of mycelium that aggregate in clusters occur on leaves during	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2.	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
roseipellis)	cool, humid weather. Patches of affected turf range in size up to 6-8 inches diameter and has a pink color. Not severely damaging to turf, but the disease is unsightly.The causal agent is a basidiomycete with clamp connections visible on hyphae when viewed microscopically.	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
Cool season grasses, but occasionally on warm season such as centipededgrass or bermudagrass		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14-28
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.3SC	3-5.9	14-28
		Concert	chlorothalonil + propiconazole 4.3SC	4.5-8.5	14-28
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
	Judiciously increase nitrogen fertility. Irrigate infrequently but thoroughly to prevent drought stress.	Secure	fluazinam 4.17 SC	0.5	14
		Disarm	fluoxastrobin 4SC	0.18-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Prostar	flutolanil 70WP, 70WDG	1.5	21-28
		Systar	flutolanil + thiophanate methyl 80WDG	2	21-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Interface	iprodione + trifloxystrobin 2.27 SC	4	14
		Banner Maxx, others	propiconazole 1.3ME	1-2	14-28
		Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		Compass	trifloxystrobin 50WDG	0.1-0.25	14-21
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Trinity	triticonazole 1.7 SC	1-2	14-28
		Curalan	vinclozolin 50EG	1	14-28
Powdery Mildew (*Blumeria graminis*)	White, powdery like growth on the upper and lower leaf surfaces of grasses. The disease is most common in excessively shaded areas with high humidities.	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2.	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
Most grasses; Kentucky bluegrass especially susceptible.		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.3SC	3-5.9	14-28
		Concert	chlorothalonil + propiconazole 4.3SC	4.5-8.5	14-28
		Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-21
		Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	14
	Improve sunlight penetration and air movement or landscape the area with non-turfgrass plants that are shade tolerant.	Rubigan AS	fenarimol AS	2-4	Single application
		Disarm	fluoxastrobin 4SC	0.18-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Eagle	myclobutanil 20 EW	1.2	14-28
		Banner Maxx, others	propiconazole 1ME	1-2	14-28
		Insignia	pyraclostrobin 20WG	0.5-0.9	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Bayleton	triadimefon 50WP, 4.15 Flo	0.5-1	15-30
Pythium Blight (*Pythium* spp.) All grasses	Grass dies in spots or streaks. Initially, the affected grass has a dark color and a greasy appearance, particularly in spots. Spots may develop a copper color and eventually a bleached, straw color as affected tissues die and dry. After prolonged moist or foggy periods, the cottony mycelium may be seen on the turf (note: this symptom is NOT always evident). Pythium can be spread by foot traffic or mowers passing over infected grasses. Occurs during warm, humid, foggy weather in poorly drained soils. Ryegrass, rough bluegrass, and bentgrass used for overseeding are most susceptible. Improve aeration and drainage. Avoid frequent, shallow irrigation. Reduce mowings and minimize equipment or foot traffic across infected turf. Wash equipment that passes from infected to non-infected grass areas.	Heritage	azoxystrobin 50WG; no more than 2 sequential sprays	0.4	10-14
		Heritage TL	azoxystrobin 0.8TL; no more than 2 sequential sprays	1-2.	10-14
		Heritage G	azoyxystrobin 0.31G	2-4 lb	10-14
		Headway	azoyxystrobin + propiconazole 1.4ME	3	10-14
		Headway G	azoxystrobin + propiconazole 1.06G	2-2.5 lb	14
		Terraneb 65SP	chloroneb 65 SP	4	5-7
		Terraneb F	chloroneb 2.9F	7	5-7
		Disarm C	chlorothalonil + fluoxastrobin 4.25 SC	3-5.9	7-14
		Vitalonil	chlorothalonil + potassium phosphite 5.27 SC	5	7-14
		Segway	cyazofamid 3.3SC	0.45-0.9	14-21
		Koban	ethazole 30WP	2-4.5	10
		Terrazole	ethazole 35WP	2-4	10-14
		Disarm	fluoaxastrobin 4SC	0.18-0.36	7-14
		Disarm G	fluoaxastrobin 0.25G	2.3-4.6 lb	14
		Stellar	fluopicolide + propamocarb 5.7SC	1.2	14
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	14
		Signature, Prodigy, Fosetyl Al 80WDG	fosetyl Al 80WDG	4-8	14-21
		Protect DF	mancozeb 75DF	8	5-10
		Fore F	mancozeb 4LF	14	5
		Junction	mancozeb + copper hydroxide 60DF	2-4	5
		Maneb plus Zinc	maneb (37%)+ zinc F	12.8	5
		Subdue Maxx	mefanoxam 2ME	0.5-1	10-21
		Subdue WSP	mefanoxam 43WSP	0.28-0.56	10-21
		Subdue G	mefanoxam 1G	12.5-25 lb	10-14
		Subdue	metalaxyl 2MEC	1-2	10-21
		Biophos	phosphorous acid salts 4.52	8-16	14-21
		Alude	phosphorous acid salts 5.17F	5-10	7-14
		Appear	potassium phosphite 4.1 lb/gal	3-6	7-14
		Banol	propamocarb 6S	1.3-4	7-21
		Insignia	pyraclostrobin 20 WDG	0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	10-14
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14

Note: Fungicides containing copper hydroxide may be phytotoxic; read label carefully & use precautions. ***To minimize the potential for resistance, alternate between classes of fungicides.***

Note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Pythium Root Rot /Pythium Root Dysfunction (*Pythium arrhenomanes, P. aristosporum, P. volutum*.) Creeping bentgrass primarily	Roots are off color, tan or light brown, water-soaked appearance with few or no feeder roots present. Sometimes, new roots may be initiated from crown regions as older roots become diseased. Root rot is favored in poorly drained or continuously wet soils but can occur in sand-based rootzones with excellent drainage. Areas will appear chlorotic and be less vigorous in growth, but usually do not die. Can occur year around, especially on over-irrigated sites. Avoid overwatering. Aerate compacted and poorly drained soils. Foliar fertilizer treatments may be useful.	Heritage	azoxystrobin 50WG; no more than 2 sequential sprays	0.4	10-14
		Heritage TL	azoxystrobin 0.8TL; no more than 2 sequential sprays	2	10-14
		Heritage G	azoxystrobin 0.31G	2-4 lb	10-14
		Headway	azoxystrobin + propiconazole 1.4ME	3	10-14
		Headway G	azoxystrobin + propiconazole 1.06G	2-2.5 lb	14
		Terraneb 65SP	chloroneb 65SP	2-5	7-14
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	7-10
		Segway	cyazofamid 3.33SC	0.45-0.9	14-21
		Koban	ethazole 30WP	2-5	7-14
		Terrazole	ethazole 35WP	2-4	10-14
		Disarm	fluoxastrobin 4SC	0.18-.36	7-10
		Disarm G	fluoaxastrobin 0.25G	2.3-4.6lb	14
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	14-28
		Signature, Prodigy, Fosetyl Al 80WDG	fosetyl Al 80WG	4-8	14-21
		Appear	potassium phosphite 4.1 lb/gal	6-8	7-14
		Banol	propamocarb 6S	1.3-4	7-21
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.7	14-28
		Insignia	pyraclostrobin 20WG	0.9	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14
		Note: Water into the root-zone., except fosetyl Al formulations. ***To minimize the potential for resistance, alternate between classes of fungicides.***			
Rapid Blight (*Labyrinthula terrestris*)	Patches from a few inches up to a foot in diameter occur most commonly in salinity-stressed cool season grasses. Affected turf can be chlorotic and water-soaked. Individual leaves appear blotchy. The organism does not form a mycelium. Manage salinity by core aerification, gypsum applications and leaching regime.	Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
		Fore	mancozeb 80WP	8	14
		Protect	mancozeb 75WP	8	14
		Insignia	pyraclostrobin 20 WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28G	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14
		Compass	trifloxystrobin 50 WDG	0.15-.25	14-21
		Tartan	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Red Thread (*Laetisaria fuciformis*) fescues and ryegrasses	In winter and early spring, leaf tips appear shriveled and ragged, occurring in patches up to 6 inches in diameter. Red to orange-colored fungal "threads" appear to grow from affected leaf tips. Turf appears as if it has been cut with a	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14-28
		Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112 F	2-5.4	7-14

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	dull rotary mower. The disease is favored by cloudy, cold, humid weather. Maintain adequate fertility, and avoid transient drought conditions. Mow frequently at the correct cutting height.	Daconil Weather Stik, Chlorthalonil 720 SFT, others	chlorothalonil 6F	2-3.6	7-10 pre-disease
				>3.6-5.5	14 post-disease
				5.5	14 post-disease
		Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil 4.16F	2.9-5.1	7-10 pre-disease
				>5.1-7.9	14 post-disease
				7.9	14 post-disease
		Daconil Ultrex, Chlorothalonil DF	chlorothalonil 82.5%WDG, DF	1.8-3.2	7-10 pre-disease
				>3.2-5	14 post-disease
				5	14 post-disease
	Note: chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details.	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-28
		Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75	7-10
		Concert	chlorothalonil + propiconazole 4.3SC	3-5.9	14-28
	Note: Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	Instrata	chlorothalonil + propiconazole + fludioxanil 3.5SC	2.75-6	14-21
		Consyst	chlorothalonil + thiophanate methyl 67WG	3-8	7-21
		Spectro 90	chlorothalonil + thiophanate methyl 90WG	3.72-5.76	14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
		Rubigan AS	fenarimol 1AS	8	30
		Secure	fluazinam 4.17 SC	0.5	14
		Disarm	fluoxastrobin 4SC	0.18-.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Prostar	flutolanil 70WP, 70WDG	1.5	21-28
		Systar	flutolanil + thiophanate methyl 80WG	2-3	14-21
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Chipco 26GT, iprodione pro, others	iprodione 2F, 2SC	4	14
		26/36	iprodione + thiophanate methyl 3.8F	2-4	14-21
		Interface	iprodione + trifloxystrobin 2.27 SC	4	14
		Fore	mancozeb 80WP	4-8	7-14
		Protect	mancozeb 75DF	4-8	7-14
		Fore F	mancozeb 4LF	7-14	7-14
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Maneb plus Zinc	maneb (37%)+ zinc F	6.4-12.8	7-14
		Tourney	metconazole 50WDG	0.37	14-21
		Eagle	myclobutanil 20 EW	1.2	14-21
		Affirm	polyoxin 11.3%WDG	0.88	7-14
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx	propiconazole 1.3ME	2	14-21
		Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Torque	tebuconazole 3.6F	0.6	28
		3336 WSP	thiophanate methyl 50WSP	2-4	14
		3336F	thiophanate methyl 4F	2-4	14
		TM 85WDG	thiophanate methyl 85WG	0.67-1.3	14
		Spotrete	thiram 4F	3.75-7.5	3-10
		Bayleton	triadimefon 50WSP, 4.17 Flo	0.5-1	15-30
		Compass	trifloxystrobin 50WDG	0.1-0.25	14-21
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Trinity	triticonazole 1.7SC	0.5-1	14-28
		Triton	triticonazole 70WDG	0.15-0.3	14-28
		Curalan	vinclozolin 50EG	1	14-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Rust (*Puccinia* and *Uromyces* spp.) bermudagrass ryegrass, St. Augustinegrass tall fescue zoysiagrasses	Small yellow to orange or reddish-brown pustules on the leaves. Heavily infected area appears thin and chlorotic. Ryegrass and zoysiagrasses are most susceptible. Plant resistant or tolerant varieties. Maintain growth by fertilizing and irrigating adequately. Mow frequently and remove clippings. Humid weather following a drought period favors epidemics. ***note:*** chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details.	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoxystrobin + propiconazole 1.4ME	1.5-3.0	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Daconil Weather Stik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	4-5.5	14 pre-disease
				5.5	14 post-disease
		Daconil Zn, Chlorothalonil 500 Zn, others	chlorothalonil 4.16 F	5.8-7.9	14 pre-disease
				7.9	14 post-disease
		Daconil Ultrex	chlorothalonil 82.5% WDG	3.6-5	14 pre-disease
				5	14 post-disease
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-28
		Concert	chlorothalonil +propiconazole 4.3SC	3-8.5	7-28
		Instrata	chlorothalonil +propiconazole + fludioxanil 3.6SC	2.75-6	14-28
		Consyst	chlorothalonil + thiophanate methyl 67WG	3-8	7-14
		Spectro 90	chlorothalonil +thiophanate methyl 90WG	3.72-5.76	14
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
		Secure	fluazinam 4.17 SC	0.5	14
		Disarm	fluoxastrobin 4SC	0.18-0.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
		Protect DF	mancozeb 75DF	4	7-14
		Fore, others	mancozeb 80WP	4	7-14
		Fore F, others	mancozob 4LF	5-7	7-10
		Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
		Maneb plus Zinc	maneb (37%)+ zinc F	1.76	7-14

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Tourney	metconazole 50WDG	0.37	14-21
		Eagle	myclobutanil 20 EW	1.2	14-28
		Banner Maxx, others	propiconazole 1.3ME	1-2	14-28
		Insignia	pyraclostrobin 20 WDG	0.5-0.9	14-28
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14-28
		Torque	tebuconazole 3.6F	0.6	28
		3336 plus	thiophanate methyl 2F	4-8	14-28
		3336	thiophanage methyl 50WP, 4F	4-6	14
		TM 85WDG	thiophanate methyl 85WG	2.35-3.53	14
		Spotrete	thiram 4F	3.75-7.5	3-10
		Bayleton	triadimefon 50WSP, 4.17 Flo	0.5-1	15-30
		Compass	trifloxystrobin 50WDG	0.1-0.25	14-21
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14-28
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
		Trinity	triticonazole 1.7SC	0.5-1	14-28
		Triton	triticonazole 70WG	0.15-0.225	14-28
		Triton Flo	triticonazole 3SC	0.28-0.55	14-28
		note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Southern Blight (*Sclerotium rolfsii*) Creeping bentgrass, bluegrasses, fescues, and ryegrasses	Yellow, circular or crescent shaped patches up to 1 ft in diameter, sometimes with "frog-eye" symptoms or less affected grass in the center of patches. Affected turf is a reddish-brown or bronze coloration, turning brown as it dies. Off-white or tan fungi sclerotia may be visible in the mat or thatch with a hand lens. Avoid drought conditions preceding hot, humid or wet weather; improve poorly drained soils and improve aeration to roots and crowns.	Heritage	azoxystrobin 50WDG	0.2-0.4	14-28
		Heritage TL	azoxystrobin 0.8TL	1-2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Terraneb SP	chloroneb 65SP	4	5-7
		Disarm	fluoxastrobin 4SC	0.18-.36	14-28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
		Prostar	flutolanil 70WP, 70WDG	1.5	21-28
		Systar	flutolanil + thiophanate methyl 80WG	2	21-28
		Bayleton	triadimefon 50WSP, 4.15 Flo	0.5-2	14-28
		Tartan	trifloxystrobin + triadimefon 2SC	1-2	14
		Armada	trifloxystrobin + triadimefon 50WP	0.6-1.2	14
Slime Mold (*Physarum* sp., and *Fuligo* sp.) All grasses	Bluish-gray encrustations on leaf blades. In spring and summer during heavy rain, prominent white or yellow slimy masses may develop. Slime molds are not parasites of turf. Brush off or wash off mold with a strong stream of water. Mow.	Fore, others	mancozeb 80WP	4-8	7-14
		Protect	mancozeb 75DF	4-8	7-14
		Fore F, others	mancozeb 37%F	6.4-12.8	7-14

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Spring Dead Spot - *(Ophiosphaerella korrae, Ophiosphaerella narmari,* or *Ophiosphaerella herpotricha*) bermudagrass, especially sterile hybrids	First appears as circular dead areas 6 inches up to 2 feet in diameter in the spring when the rest of the turf area turns green with new growth. Normally bermudagrass does not invade the dead areas as the growing season progresses nor do the dead areas increase in size until the next spring. *note*: scout and map diseased spots in spring, treat with fungicides in late summer through early fall. In established bermudagrass, thorough cultivation of dead areas may provide temporary recovery. Manage thatch by cultural methods, and avoid excess, unbalanced N fertilization in late summer or early fall.	Heritage	azoxystrobin 50WDG	0.4	Fall, 1 or 2 applications 1 month prior to dormancy, reapply 14-28 days later.
		Heritage TL	azoxystrobin 0.8TL	2	Fall, 1 or 2 applications 1 month prior to dormancy, reapply 14-28 days later.
		Headway	azoyxystrobin + propiconazole 1.4ME	3	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3 SC	3-8	14-28
		Rubigan AS	fenarimol 1AS	6	1 application
				4	2 applications 14-30 days apart
		Disarm	fluoxastrobin 4SC	0.36	14-28 fall
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28 fall
		Eagle, Myclobutanil 20EW	myclobutanil 20 EW	2.4	Fall, 28 days
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3ME	4	1-3 applications, 30 day interval
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methyl 4F, 50WP	4-8	Apply in fall before dormancy/reapply in spring when soil temperatures reach 55-60F.
Stripe Smut (*Ustilago striiformis*)	Tall fescue and Kentucky Bluegrass stands may become clumpy in appearance. Individual leaves appear shredded, with black linear streaks evident in the shredded leaves.	Headway	chlorothalonil + propiconazole 4.3SC	4.5-8.5	Fall or spring
		Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3 SC	3-8	14-28
		Eagle	myclobutanil 20 EW	1.2	14
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3ME	1-2	Fall or Spring.
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methyl 50WSB, 4F	4-8	14
		TM 85WDG	thiophanate methyl 85WG	3-3.53	14-21
		3336G	thiophanate methyl 2G	6-9lb	14
		Bayleton	triadimefon 50WSP	1	See label
		Tartan	trifloxystrobin + triadimefon 2SC	1	3 apps per season/ see label
		Armada	trifloxystrobin + triadimefon 50WP	0.6	See label
Bermudagrass Decline	Disorder first appears as chlorotic patches 8-24" in diameter, usually	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	spring/fall see label
		Insignia	pyraclostrobin 20WG	0.9	spring/fall see label

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
(*Gaeumanno-myces graminis* var. *graminis*) Bermudagrass **Take-all Root Rot** (same pathogen as above) St. Augustinegrass	in late summer during prolonged cloudy weather. Without control, patches will expand. Grass thins and develops bare areas. Green shoots next to chlorotic ones are common. Plants in the affected areas have poor root system, no rhizomes and very few stolons. Usually observed first on outside edge of golf course putting greens. Associated with consistent, low mowing heights. Raise cutting height to increase photosynthetic area. Do not scalp St. Augustinegrass when mowed. Increased fertility may help by encouraging rapid cover of affected areas. Topdress golf course greens frequently. Alleviate all stresses on the grass.	Insignia Intrinsic	pyraclostrobin 2.08SC	0.7	spring/fall see label
		Honor Intrinsic	pyraclostrobin + boscalid 28WDG	1.1	spring/fall see label
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	28
		Torque	tebuconazole 3.6F	0.6	28
		3336F	thiophanate methyl 41%F	4-8	7-14 in mid-July
		3336WP	thiophanate methyl 50WP	4-8	7-14 in mid-July
		Bayleton	triadimefon 50WSP, 4.17 Flo	1-2	21-28 Irrigate thoroughly after fungicide. application to move into the root zone.
Take-all Patch (*Gaeumannomyces graminis* var. *avenae*)	This is a disease primarily of creeping bentgrass Disease appears in spring or summer as patches of discolored turf which may or may not exhibit a “frog-eye” symptom; more common on fairways than greens. In severe cases, nonsusceptible ryegrass or bluegrasses may colonize the center of patches, giving the “frog-eye” symptom. Roots and crowns are rotted and symptoms may become more severe as heat and water stresses become greater. More common on newly constructed sand-based greens, fumigated greens, and/or soils with pH levels > 6.0. Utilized acidifying fertilizers, such as ammonium sulfate or ammonium chloride, but at rates of N agronomically acceptable for bentgrass growth. Apply Mn at rates recommended by soil tests. Improve root health by aeration and other accepted cultural	Heritage	azoxystrobin 50%WG	0.4	2 applications, 28 days apart in spring & fall.
		Heritage TL	azoxystrobin 0.8TL	2.	2 applications, 28 days apart in spring & fall.
		Heritage G	azoyxystrobin 0.31G	2-4lb	28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	28
		Headway	azoyxystrobin + propiconazole 1.4ME	3	14-28
		Headway G	azoxystrobin + propiconazole 1.06G	3.5-4 lb	28
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	5.9	28
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
		Rubigan AS	fenarimol 1AS	4-8	1-2 applications 30 day apart in fall.
		Disarm	fluoxastrobin 4SC	0.36	28 fall and spring
		Disarm G	fluoxastrobin 0.25G	2.3-4.6lb	28
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	28
		Tourney	metconazole 50WDG	0.37	1-2 apps/ fall
		Eagle	myclobutanil 20EW	2.4	Fall/spring 28 day
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3ME	2-4	Up to 2 applications in spring & fall.

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	practices.	Insignia	pyraclostrobin 20WDG	0.9	2 applications, 28 days apart in spring & fall
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.7	28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	28
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methyl 50WP, 4F	4-6	When disease symptoms appear, 7-14 day interval.
		3336 plus	thiophanate methyl 2F	4-8	14-28
		3336G	thiophanate methyl 2G	6-9lb	14
		Bayleton	triadimefon 50%WSP, 4.17 Flo	1-2	Early fall & early spring.
		Trinity	triticonazole 1.7SC	1.0-2.0	14-28 (fall and spring)
		Triton	tritiizonazole 70WG	0.15-0.3	14-28
		Triton Flo	triticonazole 3SC	0.55-1.1	14-28
Rhizoctonia Leaf and Sheath Spot (*R. zeae and R. oryzae*) bermudagrass centipedegrass creeping bentgrass St. Augustinegrass tall fescue	Occurs during summer months when weather is hot and humid. In cool season grasses, symptoms can closely mimic brown patch, caused by *R. solani*. In bermudagrass, the most commonly observed symptoms are necrotic rings or partial rings that vary from a few inches to a few feet in diameter. Spots may be observed on leaves at edge of rings. Dry soil may be present under ring. If rings are associated with very dry soil, see section on Localized Dry Spots.	Heritage	azoxystrobin 50WDG	0.4	14-28
		Heritage TL	azoxystrobin 0.8ME	2	14-28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoyxystrobin + propiconazole 1.4ME	1.5-3	14-28
		Daconil Weather Stik	chlorothalonil 6F	2-3.6	7-14 pre-disease.
				4-5.5	14 post-disease.
		Daconil Zn	chlorothalonil 4F	2.9-5.1 5.8-7.9	7-14 pre-disease.
		Daconil Ultrex	chlorothalonil 82.5% WG	5.8-7.9 1.8-3.2 3.6-5	14 post-disease. 7-14 pre-disease. 14 post-disease
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
		Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75-8	7-14
		Instrata	chlorothalonil + propiconazole +fludioxanil 3.59SC	2.75-6	14-21
		Spectro 90	chlorothalonil + thiophanate methyl 9090WG	3-5.76	14-21
		Medallion	fludioxonil 50%WP	0.25-0.5	14-21
		Prostar	flutolanil 70WG	2.2-4.5	14-21
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Insignia	pyraclostrobin 20WG	0.5-0.9	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
		Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	14-28
		Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	28
		note: chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details. Some other active ingredients may be useful for control but are not specifically labeled for this disease – thiophanate methyl and other fungicides in the benzimidazole class are ineffective.			
Yellow Patch (Cool weather brown patch) (*Rhizoctonia cerealis*) bentgrass, rough bluegrass, perennial ryegrass, zoysiagrass	Common in cold weather under prolonged cloudy conditions on bentgrass greens or overseeded bermudagrass greens. Yellow to orange irregular rings, with few leafspots in cool season grasses. Also in zoysia in early fall, causing leafspot symptoms in a ring-shaped pattern. Improve drainage, manage thatch accumulations	Heritage	azoyxystrobin 50WG	0.4	28
		Heritage TL	azoxystrobin 0.8TL	2	28
		Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
		Briskway	azoxystrobin + difenoconazole 1.67 SC	0.5-0.725	14-28
		Headway	azoxystrobin + propiconazole 1.4ME	3.0	28
		Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
		Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-28
		Disarm C	chlorothalonil + fluoxastrobin 4.25SC	3-5.9	14-28
		Instrata	chlorothalonil +propiconazole + fludioxanil 3.6SC	8-11	late fall
		Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	21-28
		Medallion	fludioxonil 50%WP	0.5	late fall.
		Medallion	fludioxonil 1.04SC	2	Spring/Fall
		Disarm	fluoxastrobin 4SC	0.36	28
		Disarm G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
		Prostar	flutolanil 70WP, 70WDG	1.5	30 days
		Systar	flutolanil + thiophanate methyl 80WG	1.5	21-28
		Tourney	metconazole 50WDG	0.37-0.44	Late fall
		Affirm	polyoxin 11.3%WDG	0.88	Late fall
		Endorse	polyoxin 2.5WP	4	7-14
		Banner Maxx, Propiconazole 14.3, others	propiconazole 1.3ME	3-4	Late fall
		Torque	tebuconazole 3.6F	0.6	28
		3336	thiophanate methy 4F, 50WP	4-8	Late fall
		3336G	thiophanate methyl 2G	6-9 lb	Late fall
		Triton Flo	triticonazole 3F	0.55-1.1	21-28
		Trinity	triticonazole 1.75SC	1-2	21-28
Yellow Tuft (downy mildew) (*Sclerophthora macrospora*) Creeping bentgrass, St. Augustinegrass	In creeping bentgrass, the disease is usually associated with compacted, overly wet areas. In cool season grasses, individual plants will be yellow in color, with excessive proliferation of shoots, giving a "bunchy" appearance. In St. Augustinegrass, linear, gray raised pustules can be seen in the	Signature	fosetyl Al 80WDG	4-8	14-21
		Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
		Subdue Maxx, Mefanoxam 2AQ	mefenoxam 2ME	0.5-1	10-21
		Subdue G	mefanoxam 1G	12.5-25lb	10-14
		Subdue	metalaxyl 2MEC	1-2	10-21
		Insignia	pyraclostrobin 20WG	0.5-0.9	14-28

Disease & Affected Grasses	Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	leaves, and leaves will shred longitudinally. Improve drainage, sunlight penetration; relieve compaction; provide good growing conditions.	Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28
		Honor Intrinsic	pyraclostrobin + boscalid 28G	0.55-1.1	14-28
		Pillar G	pyraclostrobin + triticonazole	3.0 lb	14-28

[1]Presence of a fungicide in this list does not constitute a recommendation. Trade names are used with the understanding no endorsement is intended nor is criticism implied of similar products not mentioned. All chemicals should be used in accordance with the manufacturer's instructions. Do not add adjuvants, surfactants, etc. to fungicides unless specified by the label. Check labels carefully to determine usage on residential, or commercial turf areas and other restrictions.

Trade Names for Common Turf Fungicides

Common Name	Trade Name Examples
azoxystrobin	Heritage, Heritage TL, Heritage G
azoxystrobin + chlorothalonil	Renown
azoxystrobin + propiconazole	Headway, Headway G
boscalid	Emerald
boscalid + chlorothalonil	Encartis
chloroneb	Terraneb SP, Terremec SP
chlorothalonil	Daconil formulations, Chlorothalonil WG, Chlorothalonil 720 SFT, Manicure, Thalonil, Concorde, Echo, others
chlorothalonil + acylbenzolar –s-methyl	Daconil Action
chlorothalonil + iprodione + thiophante methyl + tebuconazole	Enclave
cyazofamid	Segway
ethazole	Koban, Terrazole
fenarimol	Rubigan, Patchwork
fenarimol + chlorothalonil	Twosome Flowable Fungicide
fluazinam	Secure
fludioxonil	Medallion
fluoxastrobin	Disarm
fluoxastrobin + chlorothalonil	Disarm C
flutolanil	Prostar
flutolanil + thiophanate methyl	SysStar
fosetyl Al	Aliette, Aliette Signature, Chipco Signature, Prodigy, Fosetyl Al 80WDG
fluopicolide + propamocarb	Stellar
fluxapyroxad	Xzemplar
fluxapyroxad + pyraclostrobin	Lexicon Intrinsci 4.2SC
iprodione	Chipco 26GT Flo, Iprodione Pro, Ipro 2SE, others
maneb	Manex, Maneb + zinc, Dithane M-22 Special, plus others
maneb (37%)+ zinc F	Pentathlon F
mancozeb	Fore, Dithane T&O, Tersan LSR, Manzate 200 Flowable, Protect T/O, Pentathlon DF, + others
mefenoxam	Subdue Maxx, Mefanoxam AQ, others
metalaxyl	Subdue 2E, Pythium Control, Apron [4]
metconazole	Tourney
myclobutanil	Eagle, Systhane WSP, Myclobutanil 20EQ T&O
Penthiopyrad	Velista 50WDG
polyoxin D	Affirm WDG, Endorse WP
propiconazole [3]	Banner MAXX, Alamo, Propiconazole 14.3
phosphorous acid salts	Alude, Appear, Magellan, Biophos, Resyst, Vital
propamocarb	Banol
pyraclostrobin	Insignia, Insignia Intrinsic
pyraclostrobin + boscalid	Honor, Honor Intrinsic
pyraclostrobin + triticonazole	Pillar G, Pillar G Intrinsic
tebuconazole	Torque
thiophanate methyl	Cleary 3336, Fungo, SysTec 1998, Cavalier, Scotts Systemic Fungicide, TM 4.5F, TM 85WDG
thiophanate + chloroneb	Scotts Fungicide IV
thiophanate + chlorothalonil	ConSyst, Spectro 90, TM/C
thiophanate + iprodione	Scotts Fluid Fungicide, 26/36

thiophanate + maneb (mancozeb)	Duosan
thiophanate + thiram	Bromosan
thiram	Spotrete 75, Spotrete-F, Thiramad, plus others
triadimefon	Bayleton, Scotts Proturf Fungicide 7, Accost 1G, Granular Turf Fungicide, Strike 25WP
triadimefon + metalaxyl	Scotts Fluid Fungicide II
triadimefon + thiram	Scotts Fluid Fungicide III
trifloxystrobin	Compass
trifloxystrobin + triadimefon	Tartan 2.4SC, Armada 50WP
triticonazole	Trinity, Triton Flo, Triton 70WDG
vinclozolin	Curalan

Currently Available Pre-packaged Turf Fungicide Combination Products

Active ingredient -1	FRAC Code*	Active ingredient -2	FRAC Code*	Active ingredient - 3	FRAC Code*	Some Common Trade Name (s)
azoxystrobin	11	propiconazole	3	-		Headway
azoxystrobin	11	chlorothalonil	M5	-		Renown
azoxystrobin	11	difenoconazole	3			Briskway
Boscalid	7	Chlorothalonil	M5			Encartis
boscalid	7	pyraclostrobin	11	-		Honor, Honor Intrinsic
chloroneb	14	thiophanate-methyl	1	-		Proturf Fungicide IX
chlorothalonil	M5	acylbenzolar-s-methyl	P1			Daconil Action
chlorothalonil	M5	potassium phosphite	33	-		Vitalonil
chlorothalonil	M5	propamocarb hydrochloride	28			Lesco Par Systemic Fungicide
chlorothalonil	M5	propiconazole	3	-		Concert
chlorothalonil	M5	propiconazole	3	fludioxonil	12	Instrata
chlorothalonil	M5	thiophanate-methyl	1	-		Broadside, ConSyst, Peregrine, Spectro, Tee-1-Up, TM/C
chlorothalonil	M5	fluoxastrobin	11	-		Disarm C
chlorothalonil	M5	triticonazole	3	-		Reserve
copper hydroxide	M1	mancozeb	M3	-		Junction
flutolanil	7	thiophanate-methyl	1	-		SysStar
fluopicolide	43	propamocarb hydrochloride	28	-		Stellar
fluxapyroxad	7	pyraclostrobin	11	-		Lexicon
iprodione	2	thiophanate-methyl	1	-		26/36, Dovetail, Fluid Fungicide, Proturf Fluid Fungicide, Twosome
iprodione	2	trifloxystrobin	11	-		Interface

Active ingredient -1	FRAC Code*	Active ingredient -2	FRAC Code*	Active ingredient - 3	FRAC Code*	Some Common Trade Name (s)
mancozeb	M3	myclobutanil	3	-		MANhandle
mancozeb	M3	thiophanate-methyl	1	-		Duosan
metalaxyl	4	triadimefon	3	-		Proturf Fluid Fungicide II
myclobutanil	3	fluoxastrobin	11	-		Disarm M
pyraclostrobin	11	triticonazole	3	-		Pillar
thiram	M3	triadimefon	3	-		Proturf Fluid Fungicide III
thiophanate-methyl	1	thiram	M3	-		Bromosan
triadimefon	3	trifloxystrobin	11	-		Armada, Tartan

*FRAC code: M = multi-site mode of action (MOA); same numbers = fungicides with same MOA.

Turfgrass fungicides classified by chemical fungicide group.

Chemical Group (activity)	Common Name	Trade Name Examples
Acetanilide (Phenylamide) (Upward Mobile; Curative and Protective)	Metalaxyl	Subdue, Apron (seed treatment only)
	Mefanoxam	Subdue Maxx
Aromatic Hydrocarbons (Contact; Protective)	Chloroneb	Terraneb, Teremec
	Ethazole (Etridiazole)	Koban, Terrazole
	PCNB (Quintozene)	Terraclor, PCNB, Engage, Revere, Penstar, Turfcide
Benzimidazoles (Upward Mobile; Curative and Protective)	Thiophanate Methyl	Fungo 50, Fungo Flo, Cleary 3336, Systec 1998
Benzonitrile (Contact; Protective)	Chlorothalonil	Daconil Ultrex
Carbamates (Upward Mobile; Curative and Protective)	Propamocarb Hydrochloride	Banol
Demethylation Inhibitors (DMI) (Upward Mobile; Curative and Protective)	Difenoconazole	Component in Briskway
	Fenarimol	Rubigan
	Myclobutanil	Eagle WSP
	Propiconazole	Banner
	Triadimefon	Bayleton, Scotts Proturf Fungicide 7
	Metconazole	Tourney
	Tebuconazole	Torque
Dicarboximides (Local-penetrant; Protective)	Iprodione	Chipco 26019, Chipco 26GT
	Vinclozolin	Vorlan, Curalan, Touche
Dithiocarbamates (Contact; Protective)	Mancozeb	Fore, Tersan LSR, Dithane M-45, Manzate 200FL, Protect
	Maneb	Manex, security Maneb Spray, Dithane -22 Special
	Thiram	Spotrete 75, Spotrete-F, Thiramad
Phosphonates (Systemic; Curative and Protective)	Fosetyl-Al	Aliette, Chipco Signature, Prodigy
	phosphorous acid salts	Alude, Magellan, Biophos, Resyst, Vital
SDHI (succinate dehydrogenase inhibitors) (Upward mobile, Curative and Protective)	Flutolanil	Prostar, Systar
	Boscalid	Emerald, Honor
	Fluxapyroxad	Xzemplar, Lexicon
Strobilurines (Qoi) (Upward mobile, Curative and Protective-azoxystrobin) (local penetrant or mesostemic, curative and protective – trifloxystrobin)	Azoxystrobin	Heritage
	Trifloxystrobin	Compass
	Pyraclostrobin	Insignia
	Fluoxastobin	DisArm

NEMATODE CONTROL

S. Bruce Martin
Extension Plant Pathologist

Plant parasitic nematodes are small, microscopic, thread-like animals that utilize a stylet to puncture and feed from plant cells. In turf, these nematodes are root parasites. Nematodes are important turf pests in SC, particularly in sandy native soils of the Sandhills and coastal regions, but also in artificial, sand-based rootzone mixes on putting greens or athletic fields. Depending on the species of nematode and the numbers in soil, they are capable of contributing heavily to the decline of turf. However, many times weak turf is blamed on nematodes when poor cultural practices, fungi, insects, nutrient problems, soil compaction, poor drainage, or other environmental problems may be the more serious factor leading to the decline. All of these other stresses can also make nematode damage worse. Therefore, correct diagnosis is important to adequately address the problem and determine if the use of a nematicide is warranted. Nematicides vary in restrictions on their use and vary in their effectiveness against different species of nematodes. It is critical to carefully consult the label to be sure a product can be used on a particular site.

ABOVE GROUND SYMPTOMS: yellowing of turf initially, followed by wilting and slow recovery from wilt, poor response of turf to fertilization and eventual thinning in irregular shapes, followed by weed invasion. These symptoms occur over months and years.

ROOT SYMPTOMS: short, stubby roots with few branch roots compared to healthy roots. Roots may have a dark brown color, and sometimes (with sting or stubby root nematodes) exhibit swollen root tips. In sod with severe infestations, the sod strength is low.

SOIL SAMPLING: This is necessary for accurate diagnosis. Quart-size plastic bags can be obtained from the Cooperative Extension Service office in your county, and they will help you submit the samples to the nematode assay laboratory at Clemson University, associated with the Plant Problem Clinic (www.clemson.edu/**plantclinic**). The number of nematodes recovered from soil can vary greatly, depending on the time of year and the stage of crop or plant development at the time the samples are taken. Many other factors can be involved. Samples taken during the Winter and early Spring are less reliable, and in some situations certain nematodes may be missed entirely. In general, for routine assays, sample during the time of year that the turf is growing. For warm-season turfgrasses, May, June or July is a good time to detect high populations is they exist. For cool season grasses, late spring or early summer should detect damaging populations, if they exist. Diagnostic assays (those taken to determine if nematodes may be a factor) can be taken at any time: if high populations of damaging species are encountered, then certainly nematodes are a factor. However, if nematodes are not found in damaging numbers, it still doesn't preclude their role if the time of year the sample was taken is unfavorable for their survival. If nematode populations are high, determine the best approach to the problem including: improved turf management practices, planting new grass type, or chemical control. Usually a combination or integrated approach leads to the best success. Consult the SC Nematode Guidelines for sampling protocols and damage thresholds (http://www.clemson.edu/public/regulatory/plant_industry/pest_nursery_programs/plant_prob_clinic/).

Improve Turf Management Practices. Most grasses can withstand moderate numbers of most kinds of nematodes. Deep, infrequent waterings encourage deeper rooting of the turf, allowing grass to obtain more water and nutrients than a turf having a short root system due to shallow, daily waterings. Avoid excess nitrogen fertilization, as this encourages lush, succulent roots conducive to nematode population buildups. Avoid stresses to turf such as mowing too short. Alleviate compacted soils and correct any nutrient deficiencies.

Nematode Control Considerations

Because crop rotation, varietal resistance, biological control and several other disease management strategies are not always practical or effective for turfgrass nematode control, the use of nematicides is currently the most reliable approach to reducing parasitic nematode levels in turfgrass stands. Nematicides can be applied as preplant fumigants and as post-plant non-fumigant contact chemicals. Fumigants are toxic to plants and are labeled for use only before establishment of the turfgrass stand. In established turfgrass stands contact nematicides come in granular or spray formulations and are always watered in immediately after application. Some may have some insecticidal and even fungicidal activity. Some nematicides are extremely toxic to humans and animals and should be handled with all precautions indicated on the product label. No single product is effective against all nematodes on a given turfgrass species.

Nematodes and the Grasses Most Affected by Each

Turfgrass	Sting[1]	Ring[2]	Stubby-Root[3]	Lance[4]	Root-Knot[5]	Spiral[6]
Warm-season						
Centipedegrass	✓	✓	✓			✓
St. Augustinegrass	✓		✓	✓	✓	✓
Bermudagrass	✓	?	✓	✓	✓	✓
Zoysiagrass	✓	?	✓	✓	✓	✓
Cool-season						
Creeping bentgrass	✓	✓	✓	✓		✓
Tall fescue	✓		✓			✓
Ryegrasses	✓		✓			✓
Bluegrasses	✓		✓			✓

[1]Sting nematodes damage all grasses although bahiagrass is somewhat tolerant; generally found only in very sandy soils.
[2]Ring nematodes are widely distributed. Found on all turfgrasses but are considered a major pest only on centipedegrass. If populations are high enough, they can damage bermudagrass and zoysiagrass; populations may become high on bentgrass, but damage is usually minor.
[3]Stubby-root nematodes in the genus *Paratrichodorus* occur in most soil types in South Carolina and cause damage similar to sting nematodes; however they are particularly encountered in bentgrass greens, but populations capable of causing severe damage are much higher than sting nematode populations. Recently *Trichodorus obtusus* was found in limited sites, and research has shown this nematode to be much more virulent to bermudagrass and St. Augustinegrass than *Paratrichodorus*.
[4]Lance nematodes are widely distributed. They attack all turfgrasses in South Carolina, but are especially damaging to and frequently associated with St. Augustinegrass. Lance nematodes also attack bermudagrass and bentgrass and may become a predominant nematode in old greens where sting nematode has been controlled with nematicides.
[5]Root-knot nematodes are widely distributed. Found frequently in St. Augustinegrass, zoysiagrass, and bermudagrass, but can occur in all turfgrasses. The effects of these nematodes on turf are not well known, but they are believed to be injurious at high population densities. *Soil assays for larvae may not accurately reflect true infestations on perennial turfgrasses.*
[6]Spiral nematodes are frequently found on all turfgrasses, but are not believed to cause serious damage in most circumstances.

Soil Fumigation Before Planting

Soil fumigants are chemicals applied as gases or liquids that readily vaporize. They are very toxic to the turfgrass but may be used to treat soil prior to seeding or planting to reduce populations of plant parasitic nematode, weeds, fungal pathogens, and other soil-borne microorganisms. Turfgrasses established in fumigated soil show more uniform and vigorous growth. The fumigants used in turf are the gas methyl bromide, and the liquids 1,3-Dichloropropene (Telone II), 1,3-dichloropropene-chloropicrin (Telone C-17) and metam-sodium (labeled as Vapam, Sectagon or Busan 1020). All three fumigants are Restricted Use pesticides that usually require special equipment and application only by licensed professionals especially when large areas are to be treated. A granular material, Basamid Granular, can be applied with a drop spreader but generates a fumigant, methyl isothiocyanate, that is toxic to nematodes. Basamid Granular carries a 'warning' signal word on the label.

Methyl bromide is a very effective broad-spectrum biocide that has "served" the turf industry well. It is standard practice to fumigate new greens and tees and areas being replanted with methyl bromide.

When fumigants or Basamid are used the best results are usually obtained when the old sod is first stripped from the area to be treated, followed by thorough tilling of the soil at least two weeks prior to the application of the fumigant to allow adequate decomposition of old roots. Tilling loosens the soil and permits more rapid and

uniform diffusion of the fumigant. At the time of application the soil should be moist (not water-saturated). Too much fumigant escapes in dry soil and too little diffuses when pores are filled with water. The temperature of the soil should be about 50 to 80EF (at a depth of 4 inches). Too much fumigant evaporates from hot soil whereas diffusion is too slow in cold soil. For maximum effectiveness, the treated area should be sealed immediately with plastic tarp for several days. It is extremely important that the fumigated area is not recontaminated by accidental introduction of nematodes in soil clinging to tools, equipment, footwear, in run-off water, or in infested soil. Pests introduced into partially sterilized soil usually reproduce rapidly because of the lack of competition from microorganisms.

Nematicides for Established Commercial Turf

Only one of the older chemical nematicides can still be used on established turfgrass stands ***if users have it in stock***. It is an organophosphate, namely fenamiphos (Nemacur 10G or 3 EC). However, Nemacur has been withdrawn from the market and only existing stocks may be used. This material can only be used on commercial turf (including golf courses, cemeteries and industrial grounds) where the risks of exposure can be minimized. The active ingredient in the granules or emulsifiable concentrate must be carried into the soil by an adequate amount of irrigation or rain water (enough to reach the root zones and give effective control of nematodes but without product loss through leaching).

Nematicide applications should be made in autumn or spring (before nematode populations peak) during periods when soil temperatures are at or slightly above 60F. For granular formulations, gravity or “drop-type” granule spreaders are preferred (or required) over centrifugal types for more accurate application and for ensuring the safety of animals, humans and non-target plants. Experiments comparing the effectiveness of broadcast application of granules vs. subsurface injection of granules have shown similar effectiveness. Prior to application, physical soil treatments that aid soil penetration by water (such as core cultivation, vertical mowing and mechanical thatch removal) may aid in effectiveness. Applications should be followed by adequate overhead irrigation in order to wash the active ingredient into the soil and avoid exposure of people, pets and wildlife to the chemical.

The following rules are required for fenamiphos use. These measures are designed to reduce the risk of exposure to birds and aquatic organisms. It is suggested that others consider adopting these guidelines as good stewards of the environment as well as for the product. No more than 10 acres per golf course per day may be treated with Nemacur (3 EC or 10G). There must be a three-day interval before an additional 10 acres could be treated. Do not apply Nemacur closer than 10 feet from bodies of water and surface fairway drains. Total product application must not exceed 200 lb per acre per year.

At this juncture, instructions for the use of Nemacur remain the same as stated on the most current product label for other states in the Southeast. The safest guidelines are always on the product label. The product must be distributed evenly over the area to be treated and it must be washed immediately into the soil with at least 0.5 inches of water (usually up to the point when 1 inch of the top soil has become wet). Total irrigation should not result in puddling and runoff. Do not apply Nemacur where water runoff is likely to occur. The 3 EC formulation is not recommended for use on greens and tees. The purchase and use of **all** formulations of Nemacur are restricted to certified applicators for uses authorized by their certification, or to persons under their direct supervision.

The effects of nematicides are only *temporary*. Fumigants leave behind no residual active ingredients, so nematodes that survived the treatment (i.e., were too deep to be reached by it) or were brought in on the new sod can begin to re-colonize the normal turf root-zone immediately. The non-fumigant nematicides that may be applied to living turf must remain in the root-zone (top 4-10 inches in which most turfgrass roots normally grow) for several weeks to be effective. However, they will eventually dissipate from that region as a result of combined effects of leaching and decomposition. These products do not necessarily kill all nematodes that are exposed to them, but "inactivate" or paralyze many of them. Therefore, when the chemical is gone, there are usually some nematodes ready to resume feeding and reproducing. With either kind of nematicide, the treatment only provides a limited period of relief from nematode stress. The treatment cannot result in the desired improvement in turf health unless other stresses are also controlled and the nutrients (especially potassium) and water that are needed for good root growth are available.

OVER-USE OF NEMATICIDES

No nematicide is equally effective against all nematodes. When one is used frequently, nematodes that are least affected by it will have a distinct advantage over those that are most affected by it. For instance, prolonged frequent use of a product that affects lance nematodes less than other species enables lance nematodes to become dominant in that population.

Enhanced biodegradation is a phenomenon that can reduce the effectiveness of soil-applied pesticides where the same product has been used over a prolonged period

of time. Repeated application of the same chemical to soil encourages build-up of bacteria and other microbes which can metabolize ("digest") that chemical, so they can destroy it much more quickly than was the original case. The net effect is a shorter period of control from a given treatment. Enhanced microbial degradation has been reported for over 200 soil-applied pesticides, including nematicides, which have been used too frequently on a particular site. Enhanced biodegradation of Nemacur has been documented in South Carolina recently on several golf courses experiencing chronic problems with nematode control. Therefore, it is prudent to use all soil pesticides as little as necessary, to reduce chances of developing such soil microbial populations. It also seems wise to rotate or alternate among all products that are legal and effective for a particular problem, to avoid prolonged selection for microbes that can build up on a particular pesticide.

Soil fumigants used pre-plant to control pests such as nematodes and weeds.

Liquid Soil Fumigants	**Rate of Product/Broadcast**	**Comments**
Telone II (1,3-dichloropropene, 94%)	9-18 gal/A - mineral soils 24-36 gal/A - muck or peat soils	These fumigants are injected into the soil with tractor-mounted equipment. Maximum effectiveness is achieved when soil is covered with a plastic tarp for one to several days.
Telone C-17 (1,3-dichloropropene 78.3% + chloropicrin 16.5%)	10.8-17.1 gal/A - mineral soils 21.8 gal/A - muck or peat soils	Telone C-17 contains chloropicrin, which is an effective fungicide as well as a nematicide. Restricted Use Pesticides. Check labels for reentry periods
Vapam (metam sodium, 32.7%)	50-100 gal/A	Apply either as a drench in water or inject by chisels. Cover after the treatment with a plastic tarp for maximum benefit. Restricted Use Pesticides.
Vapam HL (metam sodium, 42%)	30-75 gal/A	
Gaseous Soil Fumigants	**Rate of Product/Broadcast**	**Comments**
Methyl Bromide Terr-O-Gas	1-2 lb/100 ft^2	Inject by chisels and cover immediately with a plastic tarp. Restricted Use Pesticide.
Brom-O-Gas		Available in small cans (1 lb or 1½ lb per can) for small area treatments. Must be covered with a plastic tarp to be effective. Restricted Use Pesticide
Granular Soil Fumigant	**Rate of Product/Broadcast**	**Comments**
Basamid Granular (dazomet 99%)	222-530 lb/A	This material carries a warning signal word, and is not a restricted use pesticide. It generates a gas when exposed to water, which fumigates the soil. It is more effective when tarped, but can be used with a water seal.

Nematicides for commercial turfgrass use.

Nematicide	Rate	Comments
Avid 0.15EC (abamectin 0.15lb/gal))	57 fl oz/A	Special local need label (24C) for SC. **Avid 0.15EC is the only abamectin formulation approved for nematode control**. For nematode control on golf course greens only. Apply in 2 gallons water/1000 sq.ft. with spray nozzles to deliver coarse droplets; spray onto wet turf and immediately incorporate with 0.1 inch irrigation/A. Addition of a soil wetting agent may improve performance. For sting (*Belonolaimus* spp.) and ring (*Criconemella* and related genera) nematodes only. Use 3 to 4 consecutive applications on a 14-21 day interval. Combinations of Avid 0.15EC and Heritage fungicides are recommended to reduce fungal infecions and promote healthier turf.
Nortica 5%WP (*Bacillus firmus* @ e 3 x 10^9 cfu/gram)	30-100 lb/acre	Apply in standard spray equipment to deliver desired rate; reapply on a 3 month interval as needed. Best results have been noted in the spring as bermudagrass turf resumes growth after winter dormancy
Multiguard Protect 90EC (8.68lb/gal furfural)	8 gal/A followed by 5.5 to 8 gal/A; 6 applications per season at 14-28 day intervals	For use on golf course greens, tees, practice greens and sod farms only. Requires appropriate personal protective equipment (PPE) and buffer zones. Golf courses must be closed during application, with a 2 hour re-entry interval to treated zones. See label for details. Apply at 1:9 dilution with water at a rate of 8 gal/acre initially,followed by 5.5 to 8 gal/acre in subsequent treatments. Incorporate with irrigation (1/4-1/2 acre inch water) within 15 minutes of application in sandy soils.
Nemacur 10%; Turf & Ornamental Nematicide (fenamiphos 10%)	2.3 lb/1000 sq.ft. or 100 lb/A	Golf courses, cemeteries, industrial grounds; DO NOT USE on residential lawns or public recreational areas other than golf courses; not for use on turf being grown for sale or other commercial use as sod, or for commercial seed production, or for research purposes. Irrigate immediately with at least ½ inch of water; do not allow puddling or run-off to occur. Do not treat newly-seeded areas until plants have developed secondary root systems. Restricted Use Pesticide. See product label for further application restrictions. Not to exceed 200 lbs/acre/year. No longer for sale; existing stocks in possession of manager can be used by label.
Nemacur 3 Turf (fenamiphos 35%)	9.7 fl oz/1000 sq.ft. or 3.3 gal/A	Use on golf courses, cemeteries, and industrial grounds; not recommended for tees or greens. DO NOT USE on residential lawns or public recreational areas other than golf courses; not for use on turf being grown for sale or other commercial use as sod, or for commercial seed production, or for research purposes. Apply dosage in minimum of ½ gallon of water per 1000 sq.ft. (min. 20 GPA). **Irrigate immediately** after treatment with a minimum of ½ inch of water. Do not treat newly seeded areas until plants have developed secondary root systems. Do not apply more than twice per year. Restricted Use Pesticide. Do not apply to more than 10 acres per golf course per day; wait 3 days before treating any additional area. See product label for further application restrictions. No longer for sale; existing stocks in possession of manager can be used by label.
Curfew EC Soil Fumigant (1,3-dichloro-propene 97.5%)	3-5 gal/acre broadcast basis	Special local need label. For golf course use only, by certified commercial applicators. Do not re-enter treated areas for 24 hours. Do not apply within 30 feet of any occupied structure, such as a school, hospital, business or residence. Curfew should be placed a minimum of 5 inches deep, with soil moisture adequate to provide good turfgrass growth, and such moisture content maintained for 7 days post-application. Immediately after application, apply ¼ to ½ inch of irrigation.

[1]The presence of a nematicide in this list does not constitute a recommendation. Trade names are used with the understanding that neither no endorsement is intended nor is criticism implied of similar products, which are not mentioned. All chemicals should be used in accordance with the manufacturer's label.

Nematicide Registration Sites

Nematicide	Golf Greens	Fairways	Tees	Sod Farms	Sports Fields	Cemeteries	Industrial Grounds	Home Lawns
Avid	YES	NO	NO	NO	NO	NO	NO	NO
Nortica	YES	YES	YES	YES	YES	YES	YES	YES
Multiguard Protect	YES	NO	YES	YES	NO	NO	NO	NO
Nemacur 3	YES	YES	YES	NO	NO	NO	NO	NO
Nemacur 10G	YES	YES	YES	NO	NO	YES	YES	NO
Curfew EC	YES	YES	YES	NO	YES	NO	NO	NO

Carrier Water Quality Influences Pesticide Stability

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Tank-mixing pesticides and fertilizers is a convenient and cost effective way to apply two or more chemicals at once. When done appropriately, tank-mixing can reduce labor and equipment costs, and save time and energy. Carrier water is the water you put in the tank to dilute your chemicals and to apply them with. Carrier water makes up ~95% of what you are applying. Certain water chemistry can potentially react with, and change the efficacy of, pesticides in both positive and negative ways. This article will discuss the origins of water chemistry, and how to take a water sample and determine the water quality. This article will also discuss the influence of and the remedies for common problematic water components.

Origins of Water Chemistry

The chemical and physical properties of minerals (i.e. mineralogy) and weathering influence water chemistry. Weathering is the decomposition process of rocks, minerals and soils by physical (ex: degradation by microorganisms and cracking by ice formation) and chemical (reactions between water and minerals) processes. Weathering results in different compounds as solutes and/or particulates within the water column.

Here is an example of how mineralogy and weathering may influence water chemistry in South Carolina: Limestone, composed of mainly calcium carbonate ($CaCO_3$), is the underlying bedrock along coastal South Carolina. During each rain event, water combines with carbon dioxide in the atmosphere to form a weak acid called carbonic acid. As rain water passes over and through the limestone, the acid combines with the calcium carbonate to form calcium bicarbonate ($Ca(HCO_3)_2$), which is dissolved in the water. Calcium carbonate and calcium bicarbonate are the two principal causes of hard water.

Water chemistry is also influenced by the sources of water. Saline aquifers, tidally influenced streams and rivers, reclaimed stormwater runoff, and reclaimed wastewater have a considerable amount of salts and other particulates.

How to Test Water Sources

Use opaque plastic containers to collect your water sample. Rinse out the bottle three times with the water you will be sampling before you take the actual water sample. Place your name, location, and date on the sample bottle with a permanent marker. Place the water sample in a cooler or refrigerator until delivering to the laboratory. Make sure to submit the sample within 24 hrs of collection. Regardless of which laboratory you send your sample to, you should receive an interpretation of results as part of your report. Some water components can be determined on site with relatively little expense and will be discussed in the following sections.

Common Problematic Water Components

pH

What is it? pH or Potential of hydrogen is the measure of the concentration of hydrogen ions (H+) and hydroxide ions (OH-) in a solution. It is measured on a logarithmic scale of 1-14 with 1 = acidic (dominated by H+ ion), 7 = neutral, and 14 = alkaline (dominated by OH- ions). Water pH fluctuates diurnally (from photosynthesis and aerobic respiration) and seasonally (from increased rainfall, leaf litter, etc.). Over long periods of time, water pH tends to become more alkaline.

How does it influence pesticide efficacy? Certain pesticides undergo chemical breakdown in alkaline water (pH more than 7). The reaction is termed alkaline hydrolysis and the severity and speed in which it occurs is dependent on the pesticide, the alkalinity of the water, the length of time the pesticide is in contact with the water, and the water temperature. Insecticides, particularly organophosphates and carbamates, are more susceptible to alkaline hydrolysis than other pesticides. .In comparison, sulfonylurea herbicides are more susceptible to acid hydrolysis at pH less than 6.0. .

How to keep it from becoming a problem? Check pH regularly and add buffering agents to carrier water whenever necessary. A pocket pH meter is relatively inexpensive and easy to operate. Test the water pH before adding any chemicals. Always read the pesticide label and check the pesticide MSDS for the recommended pH range. If correction is needed, add a buffering or acidifying agent *before* adding the pesticide. The acidifying agent may include acid forming nitrogen fertilizers, straight acids and may or may not be used in conjunction with surfactants. Always apply the tank mixture as soon as possible. Buffering agents should not be mixed with fixed copper and lime fungicides; otherwise, plant damage will occur.

Salinity

What is it? The concentration of mineral salts (ex: $MgSO_4$, MgCl, CaCl, $NaHCO_3$, NaCl, KCl) dissolved in water. It is measured by electrical conductance (EC) and is commonly reported in either dS/m or mmhos/cm.
How does it influence pesticide efficacy? Salty water is alkaline and more resistant to pH changes, making adjustments with acids more difficult. Salinity of over 0.75 dS/m can stress sensitive plants and reduce absorption of systemic pesticides through plant roots. Besides what has been mentioned, not much is known about how salinity influences pesticide efficacy, or if it does at all. However, we are aware of instances in which a pesticide failed and the only water problem possible was salinity. If you have a similar problem, please have your county extension agent contact us immediately.

How to keep it from becoming a problem? Check the salinity in you carrier water if you use water from reclaimed or tidally influenced sources. Pocket EC meters are inexpensive and easy to use. Combination Temperature/pH/EC pocket meters are slightly more expensive but still reasonable. Always read the pesticide label and check the pesticide MSDS to see if any precautions should be taken. Sometimes salinity is reported as total dissolved salts (TDS). Most pocket EC meters will give you the option for either an EC or TDS readout. If a saline water source is used, an alternative water source should be identified for permanent use or for blending with the saline water. Agitators and injection tanks can be installed for water treatment with calcium or sulfur. Ask your extension agent for more information.

Water Hardness

What is it? Hard water contains a high concentration of magnesium (Mg^{2+}), calcium (Ca^{2+}), and Ferric ions (Fe^{3+}). Water hardness is reported in ppm of $CaCO_3$ equivalent. Water <50 ppm is considered "soft", 50-100 ppm is considered "medium hard", and 100 – 2000 ppm is considered "hard".
How does it influence pesticide efficacy? Hard water won't lather with soap. The cations in hard water bind with the pesticide molecules (1 cations can bind more than 2 susceptible pesticide molecules) to form insoluble salts and precipitate out of solution. 2,4-D, dicamba, glyphosate and clopyralid are susceptible to binding with hard water. Hard water can also reduce the efficacy of some surfactants and agents added to clear turbid water. Precipitates and scales formed in the sprayer can clog the nozzles and filters.

How to keep it from becoming a problem? You will have to submit a water sample to a laboratory to test for hardness. Always read the pesticide label and check the pesticide MSDS for any precautions. If correction of water hardness is needed, add an agent such as those containing sulfate, organic acids and non-ionic surfactants. Sulfate (SO^-_4) and organic acids are often used to bind with the hard minerals. Non-ionic surfactants are commonly used to enhance herbicide efficacy but it should be noted that these will not correct the problem, and another agent still needs to be used. The agent should be mixed with the carrier water before adding the pesticide. Other options are to decrease the volume of carrier water and to use a higher label rate. Spray the tank mixture immediately.

Solids

What is it? Particulates of clay, silt and organic matter that are disturbed by water movement and brought into the column. Large particulates will eventually settle to the bottom but small particulates can suspend in the water column. Collectively, the total amount of particulates is known as *turbidity* and is commonly reported in Nephelometric Turbidity Units (NTU). The small particles that remain suspended are referred to as *total suspended soilds* and are reported in mg/l.
How does it influence pesticide efficacy? These particles are both chemical and physical nuisance. Clay and silt can bind with pesticide molecules. The organic particles not only bind with pesticides but also harbor microbes that naturally degrade pesticides. The particulates can also clog filters and nozzles.

How to keep it from becoming a problem? To get an actual value of turbidity, a water sample will have to be submitted to a laboratory. The easiest way to test for a problem is to drop a quarter at the bottom of 5 gal bucket of the water. If you cannot see the coin, then the water must be treated. Always read the pesticide label and check the pesticide MSDS for any precautions on using dirty water. An inline filter can be installed to remove suspended solids. If the pump is within a surface water body, make sure that the location of the intake is not at the very bottom or close to the top of the water column. Locate an alternative water source for permanent use or to blend with turbid water. Additionally, agents can be added to help precipitate and clear the water.

Iron

What is it? It is the sixth most abundant element in the universe and is the fourth most abundant element in the earth's crust (although not commonly found in the free metal form). Iron is dissolved as water passes through the underlying rocks. The concentration of iron is reported in mg/l.

How does it influence pesticide efficacy? In the air or water, iron reacts with oxygen to form rust (oxide and hydroxide forms of iron). Rust forms faster in the presence of salt (as in certain pesticides or within the carrier water). The rust can cause reddish-brown staining. Iron also combines with organic materials and bacteria to produce slimes. Rust flakes and slimes can clog nozzles, filters and lines.

How to keep it from becoming a problem? A water sample will have to be submitted to a laboratory to get an actual value of iron concentration. Stains can appear at concentration as low as 0.3 mg/l. Treatment for excessive iron will depend on the type of problem that exists (stains, deposits, or slimes). The most common techniques include aeration followed by filtration, the use of a water softener (caution: these usually use sodium), and the use of potassium permanganate and chlorination followed by filtration. Contact your extension agent to help decide which is best for you.

Take Precautions

Always check your pesticide label and MSDS for recommendations and guidance. If you still have a question, contact the company representatives or county extension agents. **Table 1** summarizes the effect of water quality on the most commonly used and more recent pesticides.
If the irrigation source exhibits one of the above-mentioned water problems, and the pesticide requires water-in after application, the irrigation water should be treated as well. This can be done by installing inline injection tanks.

Table 1. Recommendations on the uses of selected fungicides, herbicides and insecticides in carrier water of problematic quality. The effects of water hardness and salinity on fungicides and insecticides are poorly studied; thus, the compatibility should be tested before mixing.

Common Names	Brand Names*	Water Quality				
		Acidic (pH < 6)	Alkaline (pH > 8)	Muddy	Hard	Saline
Fungicides:						
azoxystrobin	Heritage	✓	×	NR		
chlorothalonil	Daconil	✓	✓	Test		
ethazole	Terrazole	✓	✓	Test		
fenarimol	Rubigan	✓	✓	✓		
fosetyl Al	Aliette	✓	✓	×		
mancozeb	Manzate	NR	NR	Test		
mefenoxam	Subdue Maxx	✓	Test	Test		
PCNB	Terracolr	✓	Test	NR		
propiconazole	Banner Maxx	✓	✓	Test		
thiophanate methyl	Cleary3336	Test	×	Test		
trifloxystrobin	Compass	Test	Test	NR		
Herbicides:						
2,4-D amine	2, 4-D Amine	Test	NR	✓	×	✓
atrazine	AAtrex	NR	×	Test	✓	×
chlorsulfuron	Corsair	×	✓	✓	✓	✓
clopyralid	Lontrel	Test	×	✓	×	✓
dicamba	Vanquish	✓	NR	✓	NR	✓
diquat (& paraquat)	Reward	✓	✓	×	✓	✓
glyphosate	RoundUp	✓	Test	×	×	✓

halosulfuron methyl	SedgeHammer	×	✓	✓	✓	✓
MCPA	MCPA	Test	NR	✓	×	×
metsulfuron	Manor	NR	×	✓	✓	✓
sethoxydim	Vantage	✓	✓	✓	✓	✓
simazine	Princep	Test	NR	✓	✓	×
Insecticides:						
acephate	Orthene	✓	×	✓		
bifenthrin	Talstar	✓	✓	×		
carbaryl	Sevin	✓	×	NR		
chlopyrifos	Dursban	✓	×	×		
clothianidin	Arena	✓	✓	✓		
fipronil	TopChoice	✓	✓	NR		
imidacloprid	Merit	✓	Test	✓		
indoxacarb	Provaunt	✓	×	Test		
»-cyhalothrin	Scimitar	✓	×	×		
spinosad	Conserve	✓	Test	Test		
thiamethoxam	Meridian	✓	Test	✓		
trichlorfon	Dylox	✓	×	✓		

*Brand names are provided as examples. Mentioning of any products should not be considered as an endorsement.

Key:
✓ = OK.

× = Do not use.

NR = Not recommended but use soon after mixing if there is no alternative.

Test = Test for compatibility.

WEED CONTROL

Bert McCarty
Turf and Weed Control Specialist

The best defense against weeds is a dense, vigorously growing turf. By adapting the right grass to the site and following correct cultural management, including proper fertilization, mowing, and irrigation, weeds will not be able to compete as well as with the turf. Before deciding to use any herbicide, diagnose first why the turf is thin and weeds are invading. Correct the basic problem of unhealthy turf before using any herbicide. HERBICIDES ARE NOT A SUBSTITUTE FOR SOUND CULTURAL PRACTICES.

Deciding Which Herbicide to Use

The first step toward a successful weed management program is the accurate identification of the desirable and undesirable plants involved. There are about 100 weeds that commonly occur in turfgrass. These plants can be grouped as weedy grasses, grass-like weeds, sedges and broadleaf weeds. Refer to *Color Atlas of Turfgrass Weeds*, *Weeds of Southern Turfgrasses* listed on page 2 of this publication or to Turfgrass Slide Monograph, *Common Turfgrass Weeds*, available from the Crop Science Society of America, as pictorial identification guides.

Next, determine if you wish to control weeds before planting (called Pre-plant). This involves either fumigating which controls most pests such as weeds, diseases, insects, and nematodes or do you just want to nonselectively control the existing weeds. If so, nonselective herbicides do not control weed seeds, insects, diseases, nematodes, etc., like fumigation does.

Next, do you wish to control weeds before they emerge (before you see them). If so, then a preemergence (often abbreviated PRE) herbicide should be considered. This involves applying the herbicide before the weed seeds germinate. Refer to the tables on weed control efficacy by the various PRE herbicides and the one on turfgrass tolerance to decide which materials may be used for your situation. Additional information is available in the larger tables on the specific products, trade names, application rates, weeds controlled, and important comments. A separate table is provided which lists currently registered products for bentgrass and/or bermudagrass golf greens.

Weeds which have already emerged are controlled selectively in turf with postemergence (often abbreviated POST) herbicides. The tables under Postemergence Herbicides should be consulted to determine weed susceptibility to various herbicides and more important, turf tolerance to these herbicides. Separate tables are provided on grass weed susceptibility and broadleaf weed susceptibility to the various POST herbicides. Again, additional information is available in the larger tables on the specific products, trade names, application rates, weeds controlled, and important comment sections.

If you know that sedges are your problem, refer to the nutsedge control section. This lists products available, turf tolerance, weed susceptibility and additional information on each product.

Finally, the last table of the Weed Control section lists the most often used products by common names along with their corresponding trade names, manufacturers and/or distributors.

PRE-PLANT NONSELECTIVE WEED CONTROL (*Refer to Herbicide Label for Specific Use Listing*)

Common Name	Trade Name(s)	Soil Fumigant	Soil Residual/ root uptake	Foliar Uptake	Contact Activity
Ammoniated soaps of fatty acids	Quick Fire	—	—	—	Y
Bromacil	Acti-Cil, Hyvar, Opti-Kill,	—	Y	Y	—
Bromacil + diuron	Krovar	—	Y	Y	—
Dazomet	Basamid	Y	—	—	—
Diquat	Reward, Aquatrim II	—	—	—	Y
Glufosinate-ammonium	Finale, Derringer	—	—	Y	Y
Glyphosate	Gly-Flo, Prosecutor, Razor, Roundup Pro & Pro Dry, Trailblazer, Touchdown Pro, + others	—	—	Y	—
Glyphosate + diquat dibromide	QuickPRO, Prosecutor Swift Acting			Y	Y
Imazapyr	Arsenal	—	Y	Y	—
Imazapyr + diuron	Sahara	—	Y	Y	—
Metam sodium	Metam CLR, Vapam HL, Soil Prep	Y	—	—	—
Methyl bromide	MB 98, MBC, Dowfume MC-2, Brom-o-gas, Profume, Terr-o-gas	Y	—	—	—
Pelargonic acid	Quik, Scythe	—	—	—	Y
Prometon	Pramitol, Spot	—	Y	—	—
Prometon + 2,4-D	Vegemec	—	Y	Y	Y
Tebuthiuron	Spike	—	Y	—	—

Y=yes.

PRE-PLANT NONSELECTIVE WEED CONTROL (***Refer to Herbicide Label for Specific Use Listing***)

Common Name	Trade Name (rate)	Weeds Controlled	Comments
Methyl bromide	Dowfume MC-2 Brom-o-gas Profume Terr-o-gas (1 to 2 lb/100 ft^2)	Non-selective, including bermudagrass, nutsedge, and soil pathogens & nematodes	Methyl bromide is formulated as liquid gas under pressure that forms a vapor when released. One to 1½ lb material is used per 100 sq.ft. treated soils. Use the higher rate when soils are heavy in texture, wet, or soil temperatures are below 60 F. Fumigation will not be effective if soil temperature is below 50 F. Soil should be moist but not saturated when treated. Before use, the soil should be in a condition suitable for planting including seedbed preparation by plowing soil 8 to 10 inches in depth, free of clods and undecomposed organic matter, then releasing the chemical under a gasproof (plastic) cover with the edges sealed and leaving it for 24 to 48 hours. Control will be only as deep as the soil is adequately tilled. Most other soil pests are also controlled. Grass can be planted 2 to 3 days after cover removal but do not disturb soil below 2 inches when planting. Unclassified herbicide family. **Methyl bromide is a toxic material used by professional applicators only, slated to be phased out starting Jan. 1, 2005. Some methyl bromide formulations are Restricted Use Pesticides.** Hiring a contractor who specializes in fumigation is recommended for those unfamiliar with the process. Chloropicrin is added as an warning agent and will irritate eyes and lungs. Weed seeds with hard, water-impermeable seed coats such as mallow, sicklepod, Carolina geranium, dichondra, bindweed, prickly sida, white clover, redstem filaree, and morningglory are not controlled by fumigants. If soil is too wet or dry, nutsedge control may be erratic.
Metam-sodium (metham)	Vapam 33% (50 to 100 gal/A) Vapam HL 42% (30 to 75 gal/A) Sectagon	Non-selective	Both products must first decompose to the biocidal ingredient, methyl isothiocyanate, thus, inconsistent pest control often results as temperature, plant residue, and soil moisture affect this conversion. A plastic or polyethylene cover is not required but increased control usually results with one. When a cover is not used a water soil-seal method should be followed. Cultivate the soil to the desired depth of fumigant penetration. Soil temperatures should be above 50F before use. Moisten the soil and use 1 to 2 pints of metham product per 100 sq.ft. in 2 to 5 gallons of water or 8 to 10 oz of Dazomet per 100 sq.ft. of prepared soil surface. The soil should then immediately be incorporated with a rotary tiller 4 to 8 inches deep and sealed with water at 15 gals. per 100 sq.ft. Light rolling will improve soil/water seal. If a cover is available, treat the soil in front of a rotary tiller. Cover the soil for 2 days. Planting may take place 2 to 3 weeks after treatment. Aeration may be required by rototilling before planting. Metham is a dithiocarbamate herbicide member. **Read and follow all label directions. Metham is a restricted-use-pesticide** while Dazomet is not. Control of legumes, sedges from seed, and morningglories with dazomet may be erratic.
Dazomet	Basamid 99 G (255 to 450 lb/A)		
glyphosate (4 lbs ai/A)	Roundup Pro/4S Touchdown Pro + others (4 to 5 qts/A)	Torpedograss, bermudagrass, nutsedges, other perennial weeds.	These are applied only to unwanted vegetation and will not control non-germinated seeds, diseases, nematodes, or other pests. Used also for edging and trimming. Use 4 to 5 quarts per acre glyphosate (4 lb/gal) for broadcast bermudagrass control. Apply to actively growing green vegetation that is at least 4 to 5 inches tall. Wait 2 to 3 weeks after application for regrowth and re-apply. A minimum of 3 applications will be required to control bermudagrass or torpedograss. Fusilade II at 24 oz/a can be mixed with glyphosate (4 lb/gal) at 3 qts/a and applied twice for comparable control of bermudagrass (~95%) to 3 applications of glyphosate alone. However, 14 days should lapse between the last treatment and seeding. For spot treatment, Glyphosate (4 lb/gal) is applied at 2 oz. per gallon of water; Reward 2EC is used at 4 teaspoons (¾ fl oz) + 1 teaspoon of nonionic surfactant per gallon of water, QuickPRO is used at 1.5 oz per gallon while Finale 1SC is used at 1½ to 4 fl oz per gallon of water without additional surfactant. Finale has limited translocation, thus, is good for edging creeping turfgrasses. Do not apply any of these products to desirable plants. Glyphosate and glufosinate are Amino Acid Derivative herbicide family members while diquat is a bipyridyllum.
glyphosate + diquat (3.55 to 6.7 lbs)	QuickPRO 76 WG (4.5 to 9 lb/a) RazorBurn 3.11L (7.5 qts/a)	Non-selective.	
glufosinate (¾ to 1½ lbs ai/A)	Finale 1SC (¾ to 1½ gal/A)		
diquat (1 lb ai/A)	Reward 2EC (½ gal/A)		

PREEMERGENCE HERBICIDES[1] (*Refer to Herbicide Label for Specific Species and Use Listing*)

Comments. Preemergence herbicides work for 60 to 75 days and require repeat applications for season-long control. Approximate timing for preemergence crabgrass control are: March 1 in coastal and central areas and March 15-30 in Piedmont/Mountain areas. Goosegrass germinates approximately 3 to 4 weeks later than crabgrass. Annual bluegrass (annual biotypes) germinates in late summer into early fall when air temperatures drop consistently into the mid-70sF. This usually corresponds with September 15 to October 1 in coastal and central areas and September 1 to 15 in Piedmont/mountain areas. Germination is earliest in weak turf areas such as shade or wet conditions. Additional annual bluegrass germination also occurs in early winter with warm days and cold nights.

Adequate irrigation (0.25 in.) following herbicide application is necessary to ensure success. Benefin, oryzalin, pendimethalin, indaziflam, and prodiamine are not recommended on high traffic areas such as athletic fields, cart paths, par-three tees, and areas not well established. For these high traffic areas with goosegrass, use a product containing oxadiazon for annual grass control and simazine for broadleaf weed control. Many herbicides are formulated as "stand alone" products as well as on granules in combination with a dry fertilizer as "weed-and-feed" products. Fall seeded turfgrasses should not be treated with a preemergence herbicide until the following spring.

Preemergence Herbicide Efficacy Ratings (*Refer to Herbicide Label for Specific Species and Use Listing*)

Herbicide (trade name)	Crabgrass	Goosegrass	Annual bluegrass	Bittercress	Common Chickweed	FL Pusley	Foxtail, Yellow	Henbit	Lawn Burweed	Purslane	Phyllanthus sp.	Speedwell spp.	Spurges	Woodsorrel (Oxalis)
atrazine (Aatrex)	F[1]	P	E	E	E	G	P	E	G	G	–	E	G	F
benefin (Balan)	G-E	F	G-E	P	G	–	G	G	P	–	–	P	P	–
benefin+oryzalin (XL)	E	F-G	G	P	G	G	G	G	–	G	–	–	F	F-G
benefin+trifluralin (Team)	F-G	F	G	–	G	–	G	G	–	–	–	–	F	F
bensulide (Betasan, PreSan)	G-E	P-F	F	P	P	–	G	P	P	F	–	P	–	–
bensulide + oxadiazon (Goose/Crab)	E	G-E	G-E	–	G	–	G	–	–	–	–	–	G	–
dimethenamid (Tower)	G	F-G	–	G	G	G	–	G	–	G	–	–	G	G
dithiopyr (Dimension)	E	G	G-E	G	G	–	G	G	F	F	–	G	G	G
fenarimol (Rubigan)	P	P	G-E	–	P	P	–	P	P	–	–	P	P	P
indaziflam (Specticle)	E	E	E	G	–	–	G	–	–	–	–	–	–	–
isoxaben (Gallery)	P-F	P	P-F	E	E	F-G	P	G	E	G	–	G-E	G	G
mesotrione (Tenacity)	G	F-G	F	–	G	G	–	G	G	F	–	G	–	G
metolachlor (Pennant)	F-G	P-F	G	–	F	G	G	–	–	F	P	–	F	P
napropamide (Devrinol)	G-E	F	G	–	E	P	–	P	E	G	–	E	P	G
oryzalin (Surflan)	E	F-G	G-E	P	G	G	G	G	F	G	–	P	F-G	G
oxadiazon + prodiamine	E	G-E	G-E	G	G	G	G	G	F	G	F-G	G	G	G
oxadiazon (Ronstar)	G-E	E	G-E	P	P	G	G	P	P	G	F-G	G	G	G
pendimethalin (Pendulum)	E	F-G	G-E	G	E	G	G	G	G	G	F-G	G-E	G	G
prodiamine (Barricade)	E	F-G	G-E	G	G	G	G	G	F-G	G	F-G	F-G	G	G
pronamide (Kerb)	P-F	P	G-E	–	E	–	G	F-G	P	G	–	E	P	P
simazine (Princep T&O)	P-F	P	E	E	E	G	G	E	G-E	G	–	E	F-G	F

[1]**E**=Excellent, >89% control; **G**=Good, 80 to 89% control; **F**=Fair, 70 to 79% control; **P**=Poor, <70% control; – = Data not available.

These are relative ratings and depend on many factors such as environmental conditions, turfgrass vigor or health, application timing, etc., and are intended only as a guide.

Turfgrass Tolerance to Preemergence Herbicides (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Herbicides (trade name)	Annual bluegrass	Bahiagrass	Bentgrass[1]	Bermudagrass[1]	Buffalograss	Creeping bentgrass	Centipedegrass	Kentucky bluegrass	Kikuyugrass	Overseeded Ryegrass	Perennial Ryegrass	Red Fescue	Seashore Paspalum	St. Augustinegrass	Tall Fescue	Zoysiagrass
atrazine (Aatrex)	NR	NR[2]	NR	I (D)	I (D)	NR	S	NR	NR	NR	NR	NR	NR	S	NR	I-S
benefin (Balan)	I-S	S	NR	S	NR	S	S	S	NR	NR	S	S	NR	S	S	S
benefin + oryzalin (XL)	NR	S	NR	S	I (D)	NR	S	NR	NR	NR	NR	NR	NR	S	S	S
benefin + trifluralin (Team)	NR	S	NR	S	NR	S	S	S	NR	NR	S	S	NR	S	S	S
bensulide (Betasan, PreSan)	NR	S	S	S	NR	S	S	S	NR	I-S	S	S	NR	S	S	S
bensulide + oxadiazon	NR	NR	S	S	NR	S	NR	S	NR	NR	S	S	NR	NR	S	S
dimethenamid (Tower)	NR	NR	S	S	NR	NR	NR	I	NR	I	S	NR	S	S	S	S
dithiopyr (Dimension)	NR	S	S	S	S	S	S	S	S	I	S	I	S	S	S	S
ethofumesate (Prograss)[3]	NR	NR	S	S(D)	NR	S	NR	I	NR	S(D)	S	I	NR	I	I	NR
indaziflam (Specticle)	NR	S	NR	S	S	NR	S	NR	NR	NR	NR	NR	NR	S	NR	S
isoxaben (Gallery)	NR	S	NR	S	S	S	S	S	NR	I-S	S	S	NR	S	S	S
fenarimol (Rubigan)	NR	NR	NR	S	NR	S	NR	S	NR	S	NR	S	NR	NR	S	NR
mesotrione (Tenacity)	NR	NR	NR	NR	NR	NR	S	S	NR	NR	S-I	S-I	NR	S-I	S-I	NR
metolachlor (Pennant)	NR	S	NR	I	NR	NR	S	S	NR	NR	NR	S	NR	S	S	S
napropamide (Devrinol)	NR	S	NR	S	NR	NR	S	NR	NR	NR	NR	NR	NR	S	S	NR
oryzalin (Surflan)	NR	S	NR	S	S	S	S	NR	NR	NR	NR	NR	NR	S	I	S
oxadiazon (Ronstar)	NR	NR	NR	S	S	NR	NR	S	NR	I	S	S	S	S	S	S
pendimethalin (Pre-M)	S	S	NR	S	S	S	S	S	NR	NR	S	S	NR	S	S	S
prodiamine (Barricade)	NR	S	NR	S	S	S	S	S	NR	I	S	S	S	S	S	S
pronamide (Kerb)	NR	S	NR	S	S	NR	S	NR	NR	NR	NR	NR	NR	S	NR	S
siduron (Tupersan)	S	NR	I	NR	NR	S	NR	S	NR	NR	S	S	NR	NR	S	S
simazine (Princep)	NR	NR	NR	I (D)	NR	NR	S	NR	NR	NR	NR	NR	NR	S	NR	S

[1]Check herbicide label to determine if product can be used on golf course putting greens.

[2]**S**=Safe at labeled rates on mature, healthy turf; **I**=Intermediate safety - may cause slight damage to mature, healthy turf. Use only one-half the normal rate when temperatures are hot (>85 F) or if the turf is under water stress; **NR**=Not Registered for use on and/or damages this turf species.

[3]Ethofumesate is labeled only for Dormant (**D**) bermudagrass overseeded with perennial ryegrass.

These are relative rankings and depend on factors such as environmental conditions, turfgrass vigor or health, application timing, etc., and are intended only as a guide.

Preemergence Herbicides for Putting Greens (***Refer to Herbicide Label for Specific Turf Species Use Listing***).

Trade Names	Ingredients	Bentgrass	Bermudagrass	Bermudagrass to be Overseeded (refer to label for specific timing)
Weedgrass Preventer	bensulide	Y	Y	Y
Goosegrass/Crabgrass Control	bensulide + oxadiazon	Y	Y	—
Fertilizers with 0.164% dithiopyr	dithiopyr	Y	Y	—
Southern Weedgrass Control	pendimethalin	—	Y	—
Devrinol	napronamide	—	Y	—
Betasan	bensulide	Y	Y	Y
Kerb	pronamide	—	Y	Y
Revolver	foramsulfuron	—	—	Y
Rubigan	fenarimol	—	Y	Y
Tupersan	siduron	Y	—	—

Y=yes.

PRE-PLANT HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (1 to 2 lbs-sandy soil) (4 lbs-muck soil)	**Atrazine** Aatrex 4L (1-2 qts), 90DG (1.1-2.2 lbs), 80W (1.2-2.5 lbs); Purge **Simazine** Princep 90DF, 4L + others	Pre-plant for many broadleaf weeds and suppression of crabgrass	Pre-plant centipedegrass seeding and pre-plant St. Augustinegrass, centipedegrass, & zoysiagrass sprigging/sodding	Apply to centipedegrass & St. Augustinegrass plus only dormant bermudagrass & zoysiagrass. Do not use on desirable cool-season grasses. Will provide good to excellent weed control with a minimum of growth retardation to newly sprigged, sodded, or plugged turf areas at rates not in excess of 1 lb ai/A. Effectiveness will be reduced as weeds mature. Two applications are allowed per year. Do not use during spring greenup. Do not apply within the root zone of ornamentals nor within 4 months of overseeding. Atrazine is a Restricted Use Pesticide. Triazine herbicides.
mesotrione (0.125 to 0.25 lb)	Tenacity 4L (4 to 8 fl.oz.)	Pre-plant crabgrass, chickweed, speedwells, + others	Ky. bluegrass, tall fescue, perennial ryegrass, centipedegrass, St. Augustinegrass	A postemergence (primary) herbicide with some preemergence activity. Apply at grass seeding in at least 30 GPA (280 L/ha) Activate with 0.15-inch (3.8 mm) irrigation. Do not use on bentgrass, Poa annua, kikuyugrass, zoysiagrass, seashore paspalum, and bermudagrass.
metolachlor (1.8 to 3.9 lbs)	Pennant 7.8L (2 to 4 pts)	Pre-plant yellow nutsedge, annual sedge, sprangletop, some annual grasses	Pre-plant centipedgrass, St. Augustinegrass, and zoysiagrass sprigging	The higher rate will be necessary for turf grown on high organic (i.e., muck) soils. For commercial St. Augustinegrass sod production, do not use more than once every 6 weeks and do not apply more than 8 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Irrigate within 7 days after application. Acetanilide herbicide.
oxadiazon (2 to 4 lbs)	Ronstar 2G (100 to 200 lbs) Ronstar 50W (4 to 6 lbs) Ronstar Flo 3.17L (2.5 to 3.8 qts)	Pre-plant annual grasses, especially goosegrass	Post-planting bermudagrass and zoysiagrass sprigging	Safest preemergence herbicide on newly sprigged or high traffic areas. Apply to dry turf and irrigate immediately after application. Apply the wettable powder (W) and liquid (L) formulation only to bare ground or dormant turf. Oxadiazole (or Triazolinone) herbicide.
quinclorac (0.75 lb)	Drive 75 DF (1 lb) Drive XLR8 1.5L (0.5 gal)	Pre-plant crabgrass, signalgrass, barnyardgrass, foxtail, broadleaf weeds such as pennywort, speedwells, dandelion, black medic, white clover, violets	Pre-plant seeding of annual bluegrass, ryegrass, bentgrass fairways, common bermuda, Kentucky bluegrass, tall fescue, zoysiagrass	Good soil moisture should be present before treatment. Creeping bentgrass, hybrid bermudagrass, & fine fescue have intermediate tolerance. Do not apply to desirable bahiagrass, centipedegrass, St. Augustinegrass, or dichondra. Tank mixing with N or Fe may lessen turf discoloration. Add a crop oil concentrate (2 pts/a) or methylated seed oil (1.5 pts/a) to increase performance. Not labeled for golf greens or collars. Avoid drift onto ornamentals. Quinolinecarboxylic Acid herbicide.
siduron (8 to 12 lbs)	Tupersan 50WP (16 to 24 lbs)	Pre-plant crabgrass control	Pre-seeding cool-season turfgrasses	Provides ~30 days preemergence control of crabgrass in newly seeded Ky. bluegrass or fescue (red or tall) areas. Do not use on warm-season grasses. At least ½-inch of water is needed within 3 days of application for preemergence activity. Substituted urea herbicide.

PREEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (2.0 lbs-sandy soil) (4.0 lbs-muck soil)	**Atrazine** Aatrex 4L (1-2 qts), 90DG (1.1-2.2 lbs), 80W (1.2-2.5 lbs); Purge **Simazine** Princep 90DF, 4L Wynstar 90DF + others	Same as for benefin plus pennywort (dollarweed), henbit, chickweed, lawn burweed (or spurweed) and some annual sedges. Perennial broadleaf weeds such as wild garlic, dock & others usually escape.	Centipedegrass St. Augustinegrass Zoysiagrass Dormant Bermuda	Apply to centipedegrass & St. Augustinegrass plus only dormant bermudagrass & zoysiagrass. Use in dormant bermudagrass in early December plus February for winter weed control. Do not use on desirable cool-season grasses. Will provide good to excellent weed control with a minimum of growth retardation to newly sprigged, sodded, or plugged turf areas at rates not in excess of 1 lb ai/A. Effectiveness will be reduced as weeds mature. Two applications are allowed per year. Do not use during spring greenup. Pennywort is easiest to control with a late fall and/or early winter application followed by a repeat application 4 to 6 weeks later. Winter weed control also is best with fall applications. Avoid application during spring green-up. Do not apply within the root zone of ornamentals nor within 4 months of overseeding. Atrazine is a Restricted Use Pesticide. Triazine herbicides.
benefin (2 to 3 lbs)	Balan 2.5G (80 to 120 lbs) 2.5 Benefin G (80 to 120 lbs) Balan 1.5EC (1a to 2 gal)	Summer annual grasses, annual bluegrass, some selected annual broadleaves.	**Established** Bahiagrass Bermudagrass Centipedegrass Kentucky bluegrass Red fescue St. Augustinegrass Tall fescue Zoysiagrass	Apply only to well-established turf before annual weed seed germination. Due to short residual life, for continued weed control, a second application 60 to 75 days after the initial is required. For annual bluegrass control, use full rate in September. Wait to reseed or overseed with ryegrass 6 weeks following the low herbicidal rate and 12 to 16 weeks after for the high herbicidal rate. Minimum 3 month waiting period is required before sprigging or sodding. Read the label for irrigation requirements to activate the herbicide. DO NOT APPLY TO IMMATURE TURF, desirable overseeding, on golf greens, or make a spring application to fall-planted turfgrasses. Dinitroaniline herbicide.
benefin (¾ -1.13 lbs) + trifluralin (¾ -1.5 lb)	Team 2G (100 to 150 lbs) Team Pro 0.86 G (175 to 350 lbs)			Same as for benefin. For use by professional applicators only. Good for use in mixed stands containing cool and warm-season turfgrasses. Wait to reseed or overseed with ryegrass 8 weeks following the low herbicidal rate and 12 to 16 weeks after for the high herbicidal rate. Team Pro is a dry fertilizer based material containing 0.43% benefin + 0.43% trifluralin. Dinitroaniline herbicides.
bensulide (7½ to 12½ lbs)	Betasan 3.6G (209-348 lbs) Pre-San, Lescosan 7G (107-180 lbs) Pre-San 12.5G (60-100 lbs) Bensumec, Lescosan 4E (1.9-3.1 gal) ProTurf Weedgrass Preventer 8.5G (88-147 lbs)			Same as for benefin. Use high rate in fall for annual bluegrass control. Safe on overseeded areas and golf greens. If used on putting greens, apply 4 months before overseeding. Apply a light irrigation following all applications. Sulfonamide herbicide.

PREEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
dimethenamid-P (1 to 1.5 lbs ai/acre)	Tower 6L (21 to 32 oz)	Small seeded broadleaf weeds like doveweed, spurge, purslane + yellow nutsedge & some annual grasses.		Safe on established cool- and warm-season turfgrass species. Use sites include golf courses (not greens) and highway rights-of-ways but not residential or recreational turfgrass, lawns, or sod farms. Repeat applications will be needed in 6 (21 oz/a rate) to 8 (32 oz/a rate) weeks. A total yearly allowance is 64 oz/acre. A combination of dimethenamid & pendamethalin is available as Freehand.1.75G.
dithiopyr (½ lbs)	Dimension 1E (½ gal) Dimension Ultra 40WSP (0.95 lbs)	Same as for benefin, plus oxalis (woodsorrel)		Same as for benefin. Do not use within 3 months of seeding or sprigging. A total of 1½ lb ai/A is allowed yearly not to exceed ½ lb ai/A per application. Provides early (1 to 3 leaf stage) postemergence crabgrass (some species) control. For preemergence *Poa annua* control, a 8 week interval is needed before ryegrass overseeding. Refer to label for additional timing and rate options. Each 5 oz water soluble bag of Dimension Ultra 40WSP contains 0.125 lb dithiopyr. Pyridine herbicide.
fenarimol (see comment)	Rubigan 1AS (see comment)	Annual bluegrass; also a fungicide	Bermudagrass	A systemic fungicide that reduces *Poa annua* populations. Use 3 applications spaced 10-14 days apart with the third 2 weeks prior to ryegrass overseeding and 30 days prior to *Poa trivialis* or bentgrass overseeding. Use 4 oz/1000 sq.ft. each for 3 applications; or 6 oz/1000 sq.ft. each if 2 applications are used instead of 3. In heavy weed pressure sites, a follow-up of 2 oz/1000 sq.ft. will be needed in early January for season-long control. See supplemental label for more information. DeMethylation Inhibitor (DMI) fungicide. NOTE: This product will voluntarily become unavailable in 2014.
flumioxazin (0.375 lbs)	SureGuard 51WDG (12 oz/acre)	Winter annual broadleaf weeds, preemergence crabgrass	**Dormant** bermudagrass	A contact product for **dormant** bermudagrass for rapid postemergence nonselective winter annual broadleaf control with subsequent preemergence crabgrass control. Best winter annual broadleaf control is with early winter applications. Best preemergence crabgrass control are with late winter applications. Allow 8 weeds after application before seeding or sodding. BroadStar 0.25G is a granular formulation. Dicarboximide herbicide.
indazaflam (0.027 to 0.047 lb or 30 to 80 g ai/ha) 0.027 to 0.044 lb	Specticle 20WP (2.1 to 3.75 oz) Specticle 0.622L (5.4 to 10 oz)	Goosegrass, crabgrass, annual bluegrass plus various broadleaves	**Established** Bermudagrass, Zoysiagrass, Centipedegrass, St. Augustinegrass	Do not use on cool-season turfgrasses or on bahiagrass or Seashore Paspalum. **Turf must be well established before use**. Possesses long soil residual, thus, has extended, sprigging, seeding and overseeding restriction occur. A 15-ft buffer is suggested between treated areas and adjacent cool-seaon grasses. Cellulose biosynthesis inhibitor. Alkalyazine herbicide.

PREEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
isoxaben (½ to 1 lb)	Gallery 75W (0.66 to 1.33 lbs)	Broadleaves such as chickweed, clover, henbit, bittercress, spurge, plantain, and others	Bahiagrass Buffalograss Bentgrass Bermudagrass Centipedegrass Chewings Fescue Perennial Ryegrass St. Augustinegrass Tall Fescue Zoysiagrass	Control is best for annual broadleaf weeds. Tank mix with another preemergence grass herbicide for satisfactory grass weed control. In order to activate the material, ½" water is needed following application. Not labeled for golf greens or tees. Do not reseed nor overseed within 60 days after application. Do not apply to newly seeded turf until it has been mowed 3 times. Benzamide herbicide.
metolachlor (1.8 to 3.9 lbs)	Pennant Magnum 7.62 L (1.9 to 4.1 pts)	Yellow nutsedge, annual sedge, sprangletop, some annual grass (e.g., crabgrass) suppression	**Established** bermudagrass golf course fairways; zoysiagrass, centipedgrass and St. Augustinegrass sod farms and commercial lawns	The higher rate will be necessary for turf grown on high organic (i.e., muck) soils. For commercial St. Augustinegrass sod production, do not use more than once every 6 weeks and do not apply more than 8 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Do not use Pennant on golf greens, tees, or aprons or within 4 months of overseeding or 6 months after overseeding. Irrigate within 7 days after application. Acetanilide herbicide.
napropamide (2.0 lbs)	Devrinol 50WP (4.0 lbs) Devrinol 2G (100 lbs) Devrinol 5G (40 lbs)	Same as for benefin	**Established** Bahiagrass Bermudagrass Centipedegrass Kentucky bluegrass Red Fescue St. Augustinegrass Tall Fescue Zoysiagrass	Do not apply to immature turf less than 3 months old. A second application 8 to 10 weeks after the first is suggested. Check specific label for putting greens use. Use the reduced rates for turf maintained at lower mowing heights. Irrigate after application. Do not reseed or overseed within six months after application. Susceptibility of cool-season turfgrasses may limit its use in overseed turf. Amide herbicide.
oryzalin (1½ to 3 lbs)	Surflan 4AS (1½ to 3 qts)	Same as for benefin, plus goosegrass		Same as for benefin. Use a 1½ + 1½ lb ai/A split application approximately 60 to 75 days apart for best results. Most stable preemergence herbicide, allowing 21 days before rainfall or irrigation is needed for activation. Wait to reseed or overseed with ryegrass 90 to 120 days following application. Spring application on overseeded, cool-season grasses may prematurely thin them. Dinitroanaline herbicide.
oryzalin (1-1½ lbs) + benefin (1-1½ lbs)	XL 2G (100 to 150 lbs)			Same as for benefin. Dinitroanaline herbicide.

PREEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
oxadiazon (2 to 4 lbs)	Ronstar 2G (100 to 200 lbs) Ronstar 50W (4 to 6 lbs) Ronstar Flo 3.17L (2.5 to 3.8 qts)	Same as for benefin, especially for goosegrass	Bermudagrass Buffalograss Kentucky Bluegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	**Do not apply to wet turf, golf greens, or to home lawns**. Ronstar 50WP and Flo can be used only on dormant bermudagrass, St. Augustinegrass, or zoysiagrass turf or excessive phytotoxicity will result. Thoroughly irrigate following application to increase effectiveness. A combination of oxadiazon (1%) plus benefin (0.5%) on a 38% ureaformaldehyde nitrogen fertilizer is available as Regal Star. Apply at 200 lbs/a (2 + 1 lbs ai oxadiazon + benefin/a). Another combination of oxadiazon + prodiamine is available as Regalstar II 1.2G. It is on a 38% UF nitrogen fertilizer and is applied at 200 lbs/A (2 + 0.4 lbs ai oxadiazon + prodiamine/A). Oxadiazole (or Triazolinone) herbicide.
oxadiazon (1½ lb) + bensulide (6 lbs)	Goosegrass/Crabgrass Control 6.56 G (115 lbs)	Same as for benefin, plus goosegrass, oxalis, speedwell		Same as for oxadiazon. On overseeded golf greens, apply one-half maximum labeled rate to dry turf followed by the other half 10 days later. See label for precaution concerning use on putting greens. Contains 5.25% bensulide + 1.31% oxadiazon. Apply only to dry turf and when temperatures are <80F & irrigate-in immediately with ¼ to ½-inch water. Do not overlap on greens.
pendimethalin (1.5 to 3.0)	Pendulum 60 DF Pendulum Aquacap (see label)	Same as for benefin plus oxalis and speedwell.	Same as for benefin.	Do not use on newly sprigged turfgrasses. Not recommended for areas thinned from winter stress. Do not reseed within 4 months of application. Use low rate on tall fescue and Kentucky bluegrass, high rate may be used on warm-season grasses.
prodiamine (¾ lbs)	Barricade 65WG (1.15 lbs) Barricade 4L (1½ pints) ProClipse 65 WDG (1.15 lbs) RegalKade (check label)	Same as for benefin plus chickweed, spurge, goosegrass	**Established** Bahiagrass Bermudagrass Centipedegrass Kentucky bluegrass Red Fescue St. Augustinegrass Tall Fescue Zoysiagrass	Same as for benefin. Split applications at 0.38 to 0.75 lbs ai/A 60 to 75 days apart should be used for extended control and will be required for goosegrass suppression. May be applied to established ryegrass. Do not apply more than twice yearly or to golf greens. RegalKade formulations are on a 32-3-12 dry fertilizer carrier and include a 0.5G and 0.37G formulation. Dinitroanaline herbicide.
pronamide (½ to 1 lb)	Kerb T/O 50 W (1 to 2 lbs)	Annual bluegrass	All warm-season grasses	Safe on all warm-season grasses. Use PRE and POST only on bermudagrass. For PRE, make application at 45 to 60 days prior to overseeding. Activated charcoal can be used at 2 to 5 lbs/1000 sq.ft. to "deactivate" pronamide when applied closer than 45 days prior to overseeding. Inconsistency between years may occur with the charcoal approach. Works slowly (3 to 5 weeks); use high rate as annual bluegrass reaches maturity. **Do not apply on or upslope to desirable cool-season turf** as pronamide will move with runoff. Restricted Use Product. Amide herbicide.

[1]Presence of a herbicide in this listing does not constitute a recommendation. Trade names are used with the understanding that no endorsement is intended or no criticism is implied of similar products which are not mentioned. All chemicals should be used in accordance with the manufacturer's instructions.
[2]All herbicide rates are active ingredient rates per acre. For product rates for formulations not listed, check the label included with every herbicide container.
The following conversions may be useful. Gal/acre x 2.938 = oz/1000 ft^2; Qt/acre x 0.7346 = oz/1000 ft^2; Pint/acre x 0.3673 = oz/1000 ft^2; lbs/acre x 0.02296 = lb/1000 ft^2.

POSTEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Best results occur when young, actively growing weeds are treated with good soil moisture and air temperatures <85 F (29 C). Repeat applications, 10 to 14 days apart, may be required for acceptable control. Do not mow or irrigate within 48 hrs after application for most chemicals. Read the label to see if a spreader-sticker, adjuvant, crop oil, or wetting agent are needed.

Established Turfgrass Tolerance to Postemergence Broadleaf Herbicides (*Refer to Herbicide Label for Specific Species Listing*)

Herbicides	Bahiagrass	Bentgrass Fairways	Bentgrass Greens	Bermudagrass	Buffalograss	Carpetgrass	Centipedegrass	Fine Fescue	Kentucky bluegrass	Kikuyugrass	Overseeded Ryegrass/Blends	Ryegrass	Seashore Paspalum	St. Augustinegrass	Tall Fescue	Zoysiagrass
amicarbazone (Xonerate)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
aminocyclopyrachlor (Imprelis)	S	NR	NR	NR	NR	NR	S	S	S	NR	S	S	NR	NR	S	S
atrazine (Aatrex)	NR[1]	NR	NR	S-I(D)	I (D)	I[3]	S	NR	NR	NR	NR	NR	NR	S	NR	I
bentazon (Basagran T&O)	S	I	NR-I	S	S	S	S	S	S	NR	S-I	S	S-NR	S	S	S
bromoxynil (Buctril)	S	NR	NR	S	NR	S	S	S	S	NR	S	S	NR	S	S	S
carfentrazone (QuickSilver)	S	S	NR	S	S	NR	S	S	S	NR	S	S	S	I	S	S
carfen.+2,4-D+MCPP+dicamba (Speed Zone North.)	NR	S	NR	S	NR	NR	NR	S	S	NR	S	S	NR	NR	S	S
carfen.+MCPA+MCPP+dicamba (Power Zone)	NR	NR	NR	S	NR	NR	NR	S	S	NR	S	S	NR	NR	S	S
carfen.+2,4-D+MCPP+dicamba (Speed Zone So.)	S	S	NR	S	S	NR	S	S	S	NR	S	S	S	S	S	S
chlorsulfuron (Corsair, TFC)	I	I	NR	S	NR	I	I	I-S	S	NR	NR	NR	S	I	NR	I
clopyralid (Lontrel)	S	I	NR	S	S	S	S	S	S	NR	S	S	NR	S	S	S
2,4-D	S	NR	I[1]	S	I	I	S-I	S	S	S	S-I	S	S	I	S	S
MCPP (mecoprop)	S	I	S	S	I	I	I	S	S	NR	I	S	S	I	S	S
dicamba (Vanquish)	S	I	I	S	I-NR	I	I	S	S	NR	I	S	S	I	S	S
2,4-D + dichlorprop (2,4-DP)	S	I	I	S	S	I	I	S	S	S	S	S	S	I	S	S
2,4-D + triclopyr (Turflon)	NR	NR	NR-I	NR	NR	NR	NR	I	S	NR	S	S	NR-P	NR	S	NR
2,4-D + MCPP + dicamba	S	I	I	S	I	I	I	S	S	NR	S	S	NR	I	S	S
2,4-D + MCPP + 2,4-DP	S	I	I	S	NR	I	I	S	S	NR	S	S	NR	I	S	S
MCPA + MCPP + 2,4-DP	S	I	I	S	NR	I	I	S	S	NR	S	S	NR	I	S	I
MCPA + triclopyr + clopyralid	S	S	S	S	S	I	S	S	S	NR	S	S	NR	NR	S	S
flumioxazin (SureGuard)	NR	D	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
fluroxypyr + 2,4-D + dicamba (Escalade)	S	I	NR	S	NR	NR	NR	S	S	NR	NR	S	NR	NR	S	S
fluroxypyr (Spotlight)	S	S	NR	S	S	S	S	S	S	S	S	S	S	S	S	S
halosulfuron (Sedgehammer)	S	I	NR	S	NR	S	S	S	S	S	S	S	S	S	S	S
iodosulfuron + dicamba + thiencarbazone (Celsius)	NR	S	NR	S	S	NR	S	NR	NR	NR	NR	NR	NR	S	NR	S
imazapic (Plateau)	NR	NR	NR	S	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR
imazaquin (Image)	NR	NR	NR	S-I	S-NR	I	S	NR	NR	NR	NR	NR	NR	S	NR	S
mesotrione (Tenacity)	NR	NR	NR	NR	NR	NR	S	S-I	S	NR	NR	S-I	NR	S-I	S-I	NR
metsulfuron (Manor)	NR	NR	NR	S	S	I	S	I	I	NR	NR	NR	NR-S	S-I	NR	S
pyraflufen-ethyl (Octane)	S	S	NR	S	S	NR	S-I	S	S	S	S	S	NR	S	S	S
quinclorac (Drive)	NR	I	NR	S	S	NR	NR	NR	S	NR	S	S	NR-S	NR	S	S
quinclorac+sulfentrazone+2,4-D+dicamba (Q4)	NR	NR	NR	NR-I	NR-I	NR	NR	S	S	NR-I	S	S		NR	S	NR-I
simazine (Princep T&O)	NR	NR	NR	S-I(D)	S	I	S-I	NR	NR	NR	NR	NR	NR	S-I	NR	I
sulfentrazone (Dismiss)	S	S	NR	S	S	S	S	I	S	S	NR	S	S	NR	I	S
sulfentrazone + 2,4-D + dicamba + MCPP (Surge)	S	S	NR	S	S	S	S	S	S	S	S	S	NR	S	S	S
triclopyr (Turflon)	NR	NR	NR	NR	NR	NR	NR	S	S	NR	S	S	NR-P	NR	S	NR
triclopyr + clopyralid (Confront)	I	I	NR	I	S	NR	S	I	S	NR	S	S	NR-I	NR	S	S
triclopyr + dicamba + 2,4-D + sulfentrazone (Tzone)	S	S	NR	S	NR	NR	NR	S	S	NR	S	S	NR	NR	S	S

D=apply only to dormant grass.

Established Turfgrass Tolerance to Postemergence Grass Herbicides (*Refer to Herbicide Label for Specific Species Listing*).

Herbicides (trade names)	Bahiagrass	Bentgrass Fairways	Bentgrass Greens	Bermudagrass	Buffalograss	Carpetgrass	Centipedegrass	Fine Fescue	Kentucky bluegrass	Kikuyu-grass	Overseeded Ryegrass/Blends	Ryegrass	Seashore Paspalum	St. Augustinegrass	Tall Fescue	Zoysiagrass
Grass Weed Control																
amicarbazone (Xonerate)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
asulam (Asulox)	NR	NR	NR[1]	S-I[2]	NR-I	NR	NR	NR	NR	NR	NR	NR	NR	S-I	NR	NR-I
bispyribac-sodium (Velocity)[3]	NR	NR	NR	S[3]	NR	NR	NR	NR	NR	NR	S[4]	S	NR	NR	NR	NR
clethodim (Envoy)	NR	NR	NR	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR
diclofop (Illoxan)	NR	NR	NR	S	NR-S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
DSMA, MSMA, CMA	NR	I	NR-I	S-I	I	NR	NR	I	I	NR	NR	S-I	NR-P	NR	I	S-I
ethofumesate (Prograss)[4]	NR	I	NR-I	D	NR	NR	NR	I	S	NR	I	S	NR-S	NR	S	NR
fenoxaprop (Acclaim Extra)	NR-I	I	NR-I	NR-I	NR	NR	NR	S	S	NR	I	S	NR	NR	S	I
flazasulfuron (Katana)	NR	S	NR	S	S	NR	S	NR	NR	NR	NR	NR	S	NR	NR	S
fluazifop (Fusilade II)	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR-P	NR	S-I	I
foramsulfuron (Revolver)	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR	I	NR	S
mesotrione (Tenacity)	NR	NR	NR	NR	NR	NR	S	S-I	S	NR	NR	S-I	NR	S-I	S-I	NR
metribuzin (Sencor Turf)	NR	NR	NR	S-I	NR	NR	NR	NR	NR	NR	NR	NR	NR-I	NR	NR	NR
pronamide (Kerb)	S	NR	NR	S	NR	NR	S	NR	NR	NR	NR	NR	NR-S	S	NR	S
rimsulfuron (TranXit)	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
sethoxydim (Vantage)	NR	NR	NR	NR	NR	NR	S	S	NR	NR	NR	NR	NR-P	NR	NR	NR
sulfosulfuron (Certainty)	I	NR	NR	S	S	NR	S-I	NR	NR	S	NR	NR	NR	S-I	NR	S
trifloxysulfuron (Monument)	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR-P	NR	NR	S
quinclorac (Drive)	NR	I	NR	S-I	S	NR	NR	I	S	NR	S	S	NR-S	NR	S	S

[1]S=Safe at labeled rates; I=Intermediate safety, use at reduced rates; NR=Not Registered for use on and/or damages this turfgrass; D=Dormant turf only.
[2]Asulam is labeled for 'Tifway' (419) Bermudagrass and St. Augustinegrass.
[3]Used on dormant bermudagrass overseeded with perennial ryegrass.
These are relative rankings and depend on factors such as environmental conditions, turfgrass vigor or health, application timing, etc., and are intended only as a guide.

Guide to Grass Weed Control with Postemergence Turfgrass Herbicides (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Herbicide[1]	Crabgrass	Goosegrass	Annual Bluegrass	Sandspur	Dallisgrass	Thin Paspalum	Ryegrass	Smutgrass	Bahiagrass	Carpetgrass	Tall Fescue	Bermudagrass	Quackgrass
amicarbazone (Xonerate)	F-G	P	F-G	—	P	P	P	P	P	P	P	P	—
atrazine (Aatrex)	P-F[2]	P	G-E	F	P	P	G-E	F-G	F	P	F	P-F	F
asulam (Asulox)	G	F	P	F	P	P-F	–	F	P	G	P	P	–
bispyribac-sodium (Velocity)	—	—	G	—	—	—	P	—	—	—	—	P	–
chlorsulfuron (Corsair, TFC)	P	P	P	P	P	P	G	F	P	P	G	P	–
clethodim (Envoy)	E	G-E	G	G	--	–	G-E	–	–	–	P	G	G
diclofop (Illoxan)	P	G-E	P	P	P	P	G	P	P	P	P	P	—
DSMA, MSMA	G	F	P	G	F	F-G	P	P	F	G	P	P	—
ethofumesate (Prograss)	P	P	F-G*	P	P	P	P	P	P	–	P	P-G	—
fenoxaprop (Acclaim)	G-E	G-E	P	G	P	P	P	P	G	–	P	F-G	—
flazasulfuron (Katana)	F	P	G-E	—	—	—	G-E	—	—	—	F-G	P	—
fluazifop (Fusilade II)	G-E	G	F	G	P	P	G-E	P	G	–	P	G	G
foramsulfuron (Revolver)	P	G	E	–	F	—	E	—	—	—	E	P	—
imazapic (Plateau)	G	G	P	F-G	F	—	F	—	F	—	G	P	P
metribuzin (Sencor)	F-G	G-E	G	–	F	P	F	P	P	–	F	P	—
metsulfuron (Manor)	P	P	P	P	P	P	G	P	G	P	F	P	—
pronamide (Kerb)	P	P	G-E	P	P	P	G-E	P	P	–	G	P	F-G
rimsulfuron (TranXit)	P	P	G	P	P	P	G	P	P	P	P	P	P
sethoxydim (Vantage)	G-E	G	P	G	P-F	P	P	P	G	P	P	F-G	F-G
simazine (Princep T&O)	P-F	P	G-E	P-F	P	P	G-E	F	F	P	F	P-F	F
sulfosulfuron (Certainty)	P	P	G	—	P	P	P	—	P	P	G	P	G
trifloxysulfuron (Monument)	P	P	E	—	F	–	E	—	F	–	E	P	–
quinclorac (Drive)	E	P	P	—	F	P	P	P	P	P	P	P	–

[1]Repeat applications usually 5 to 14 days apart are needed for most herbicides and weeds. This is especially true as weeds mature, producing flowers and seedheads.

[2]E = excellent (>90%) control with one application;

G = good (80 to 90%) control with one application;

F = Fair to good (70 to 89%), good control sometimes with high rates, however a repeat treatment 1 to 3 weeks later each at the standard or reduced rate is usually more effective; P = poor (<70%) control in most cases.

— = Control unknown as all weeds have not been tested for susceptibility to each herbicide listed.

*Ethofumesate provides good to excellent control of most true annual biotypes of annual bluegrass but only poor to fair control of perennial biotypes.

Expected control of broadleaf weeds with turf herbicides (consult specific herbicide label for weed species listing).

Weed	Lifecycle	Amicarbazone	Aminocyclopyrachlor	Atrazine/Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D +2,4-DP	2,4-D+MCPP+ dicamba	Carfentrazone	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Chlorsulfuron	Clopyralid	Flumioxazin	Fluroxypyr	Fluroxypyr + 2,4-D + dicamba	Imazaquin	Iodosulfuron+dicamba + thiencarbazone	Mesotrione	Metsulfuron	Pyraflufen-ethyl	Quinclorac	Quinclorac + 2,4-D + sulfentrazone + dicamba	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Sulfentrazone + 2,4-D + MCPP + dicamba	Sulfentrazone	Triclopyr + dicamba + sulfentrazone + 2,4-D
Aster	P[1]	—	—	—	G	—	—	F	G	F	—	G	—	G	—	—	G	—	G	—	G	—	—	G	—	F	G	G	G	—	G
Bedstraw, smooth	P	—	—	—	P	P-F	G	F	F	G	—	G	G	—	—	E	G	—	—	—	P	G	—	G	F-G	G	G	G	G	—	G
Beggarticks	A	—	—	G	G	—	—	—	G	G	—	G	—	—	—	—	G	—	—	—	—	G	—	E	—	G	G	G	—	—	G
Betony, Florida	P	—	E	F-G[2]	F	F	F-G	F	F-G	F-G	—	G	—	—	—	—	G	—	—	G	G	—	—	G	—	G	G	—	G	—	G
Bittercress, hairy	WA	G	G	—	E	F	E	E	E	E	—	—	—	—	G	—	G	G	—	—	E	—	—	—	—	—	—	—	—	G	—
Bindweed, field	P	—	—	—	G	G	G	E-F	G	E	—	G	—	—	—	G	G	—	—	—	—	—	E	G	G	G	—	—	F-G	—	G
Burclover	A	—	—	—	F-P	E	E	E-F	E	E	—	G	F	G	—	—	G	--	—	—	G	—	—	—	G	—	—	—	F-G	—	—
Buttercups	WA,B&P	—	—	F	G	F	F-G	E	E	E	—	G	G	G	F	—	G	G	G	G	E	—	—	E	—	G	E	G	G	G	G
Buttonweed, Virginia	P	—	F	—	F	P-F	F	F	E-F	E-F	F	G	F	F	—	G	G	—	—	—	G	—	—	G	F	F-P	G	G	G	—	G
Carpetweed	SA	G	—	E	G	F	E	E	E	E	G	G	—	—	—	—	G	—	—	G	P	G	—	E	—	G	—	G	G	G	G
Carrot, wild	A,B	—	—	—	G	F	E	G	P-F	E	—	G	G	—	—	—	G	—	—	—	E	—	—	E	G	F	—	G	G	—	G
Chamberbitter	SA,P	—	G	G-E	P	—	—	—	—	—	—	—	—	—	—	—	—	P	—	—	E	—	—	—	—	E	—	—	—	—	—
Chickweed, common	WA	G	G	E	P	G	G	E	E	E	F	G	G	—	G	G	G	G	G	G	E	G	—	E	—	E	—	E	G	G	G
Chickweed, mouse-ear	WA,P	G	F-G	F-G	G	G	G	E	E	E	F	G	G	P	G	G	G	G	—	G	E	G	—	G	P-F	E-F	E	E	G	G	G
Chicory	P	—	—	—	G	E	G	E	E	E	—	G	—	—	—	—	G	—	—	—	E	—	—	G	G	G	—	G	G	—	G
Cinquefoil, common	P	—	E	—	E-F	E-F	E-F	E-F	E-F	E-F	—	G	F	—	—	—	G	—	—	—	—	—	—	G	—	—	—	—	G	G	G
Clover, crimson	SA	—	—	—	G	G	G	E	E	E	—	G	G	G	—	—	G	—	—	—	—	—	E	E	—	—	—	E	G	—	G
Clover, hop	WA	G	E	E	F-G	G	G	E	E	E	—	G	G	G	G	—	G	—	—	—	F	—	E	E	—	E	—	E	G	—	G
Clover, white	P	—	E	E	F-G	G	G	E	E	E	—	G	G	G	—	G	G	G	G	G	E	G	E	G	F-G	E-F	E	E	G	G	G
Cudweed	WA	G	E	G-E	G-E	—	E	G-E	G-E	E	—	—	—	–	G	–	G	G	G	—	E	—	—	E	—	G-E	G-E	G	G	G	G
Daisy, English	P	—	—	—	P	F	G	G	F	E	—	G	—	F	—	—	G	—		—	—	—	F	F-G	—	—	G	G	F-G	—	G
Daisy, oxeye	P,B	—	—	—	F	F	F	F	F	E-F	—	—	—	—	—	—	G	F	G	—	—	—	—	G	—	—	—	—	G	—	G
Dandelion	P	G	G	E-F	G	G	G	E	E	E	—	G	G	F-G	—	F-G	G	P-F	G	G	E	G	F-G	G	G	F-E	G	G	G	G	G
Dandelion, Catsear	P	—	G	—	E-F	F	E	E	E	E	—	—	—	—	—	—	G	—	G	—	—	—	—	G	—	G	E	E	—	—	G
Dayflower, Spreading	SA	—	—	G-E	F	F	F	F-G	F-G	F-G	—	G	—	—	—	—	--	G	—	—	G	—	P	E	—	F-G	—	—	G	—	G
Deadnettle, purple	WA	—	—	G-E	G	F	G	F	—	F-G	—	G	—	—	G	E	G	—	—	—	P	—	G	E	—	—	F	—	G	—	G
Dichondra	P	—	G	E-F	E	F	E-F	E	E	E	—	—	—	—	—	—	—	—	G	—	P	—	E	—	—	—	E	—	—	—	—
Dock, broadleaf & curly	P	—	E	F	G	F-G	F-G	G	F-G	E-F	—	G	G	G	—	—	G	—	—	G	G-E	G	—	G	F-G	G	E	—	G	G	G
Dogfennel	P	—	G	—	G	—	G	—	—	E	—	G	—	—	—	—	G	—	G	—	G	—	–	E	—	E	E	—	G	—	G
Doveweed	SA	—	—	G-E	F	F	F	F-G	F-G	F-G	—	—	—	—	—	—	—	—	G	—	P-F	—	—	—	—	F-G	—	G	—	—	—
Eveningprimrose, Cutleaf	WA	—	—	E	–	–	G	G	F	G	—	—	—	—	G	—	G	G	—	—	—	G	—	—	G	G	G	G	—	G	—
Falsedandelion, Carolina	WA,B	—	—	P	G	G	G	—	G	—	—	—	—	G	G	—	G	—	—	—	G-E	—	—	E	P	—	G	—	—	—	—
Filaree, redstem	WA	—	—	—	P-F	—	G	—	—	—	—	G	G	—	G	—	G	—	—	—	—	—	—	E	—	—	—	—	G	G	G
Garlic, wild	P	—	—	P	G	P	—	E-F	E-F	E-F	—	G	F	—	—	—	G	G	—	—	G-E	—	P	G	—	G	—	—	G	G	G
Geranium, Carolina	WA	—	E	E	E	E-F	E	E	E	E	—	G	F	—	G	—	G	G	—	—	P-F	—	—	E	—	--	—	G	G	G	G
Groundsel	WA	—	—	—	G	G	—	G	G	G	—	G	G	G	G	—	—	--	—	—	E	—	—	E	—	G	—	—	G	—	—
Hawkweed	P	—	—	—	G	P	G	E-F	E-F	E-F	—	G	—	—	—	—	G	—	—	—	—	—	—	G	—	—	G	G	G	—	G
Healall	P	—	G	—	G	P	E-F	E	E	E	—	G	—	P	—	—	G	—	—	—	G	—	—	G	P	—	E	E	G	—	G
Henbit	WA	G	G	E	F-G	F	G-E	F	E-F	E	F	G	G	—	G	F-G	G	G	G	G	E-F	G	—	E	—	E	G	G	G	G	G

Weed	Lifecycle	Amicarbazone	Aminocyclopyrachlor	Atrazine/Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D +2,4-DP	2,4-D+MCPP+ dicamba	Carfentrazone	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Chlorsulfuron	Clopyralid	Flumioxazin	Fluroxypyr	Fluroxypyr + 2,4-D + dicamba	Imazaquin	Iodosulfuron+dicamba + thiencarbazone	Mesotrione	Metsulfuron	Pyraflufen-ethyl	Quinclorac	Quinclorac + 2,4-D + sulfentrazone + dicamba	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Sulfentrazone + 2,4-D + MCPP + dicamba	Sulfentrazone	Triclopyr + dicamba + sulfentrazone + 2,4-D
Horseweed	WA,SA	—	—	E	F	—	E	—	—	G-E	—	—	—	G	—	—	—	—	G	—	G	—	F-G	—	—	E	E	—	—	—	—
Ivy, ground	P	—	E	—	F-G	G	F-G	G	F-E	E-F	F	G	—	—	—	G	G	—	G	G	G	—	—	G	G	F	G	G	G	G	G
Knawel	WA	—	G	—	P	F	E	E-F	E-F	E	—	—	—	—	G	—	G	G	G	—	—	—	—	—	—	G	—	G	—	—	—
Knotweed, prostrate	SA	—	—	E	F	F	G	G	G	F-G	—	G	G	—	—	F-G	G	—	—	—	F	G	—	E	—	G	G	G	G	G	G
Kochia	SA	—	—	—	G	—	G	G	F	G	F	—	--	—	—	—	G	—	—	—	G	G	—	—	—	G	—	G	—	G	—
Lambsquarters	SA	—	—	G	G	G	G	F	F	G	—	G	G	—	—	—	G	—	G	—	G	G	—	E	G	G	F	G	G	G	G
Lespedeza, annual	SA	—	E	E	F-P	E	E	E-F	F	E	—	G	—	G	—	—	G	—	G	—	E	—	—	E	G	G	E	E	G	G	G
Mallow	P	—	—	—	F-G	F	G	E-F	E-F	E-F	G	G	G	—	—	—	G	—	—	—	—	G	—	G	—	G	G	G	G	G	G
Medic, black	A	—	E	—	P	F	G	G	E	E	G	G	—	G	—	G	G	G	—	—	—	—	E	E	G	G	E	G	G	G	G
Moneywort	P	—	—	—	G	—	—	G	G	G	—	—	—	—	—	—	--	—	—	—	—	—	—	—	—	G	G	—	—	—	—
Mugwort	P	—	—	—	F	F-P	G-E	F	F	F	—	—	—	F-G	—	—	G	—	—	—	—	—	—	—	P-F	—	—	—	—	—	—
Mustard, wild	WA	—	—	E	G	F	G	E	E-F	E	—	G	G	—	G	—	G	—	G	—	G	G	—	E	G	G	—	G	G	—	G
Nettle, stinging	P	—	—	F-G	G	—	F	F	F	F	—	—	—	—	—	—	G	—	—	—	—	G	—	—	—	F	—	G	—	—	G
Onion, wild	P	—	—	P	G	P	F	G	F	E	—	G	F	—	—	—	G	G	—	—	G-E	—	—	G	—	—	—	—	G	G	G
Parsley-piert	WA	—	—	E	P	E-F	E-F	E-F	P	E-F	—	G	—	—	G	—	G	G	—	—	G-E	—	—	E	—	E	—	—	G	G	G
Pearlwort	WA	—	—	—	E-F	E-F	—	E-F	E-F	E-F	—	—	—	—	G	—	G	—	—	—	—	—	—	—	F	—	—	—	—	—	—
Pennywort (dollarweed)	P	—	G-E	E	G	G	E-F	E-F	E-F	E-F	F	G	—	G	—	—	G	F-G	—	—	G	—	E	G	F	—	E	E	—	—	—
Pepperweed, Virginia	WA	—	—	E	G	E-F	G	E-F	E	E	—	G	—	—	G	—	G	—	—	—	—	—	—	E	E	E	G	G	G	—	G
Pigweed	SA	—	—	G	G	G	G	E-	G	E	G	G	G	—	—	—	G	—	G	G	G-E	G	—	E	F-G	—	—	—	E	G	G
Pineapple-weed	WA,SA	—	—	—	F	F	—	F	F	F	—	G	G	G	—	—	—	—	G	—	G	G	—	E	—	F	—	—	G	G	G
Plantains	P	—	G	F-P	G	G	G	E	E	E	—	G	F	G	—	F-G	—	—	G	—	G-F	—	—	G	F-G	F-G	E	E	G	G	G
Purslane, common	SA	G	G	G	G	F	G	G	G	E-F	—	G	G	—	—	E	—	—	—	—	G	G	—	E	G	—	—	G	G	G	G
Pusley, Florida	SA	—	F-G	–	G	—	G	—	F	G	—	G	—	G	—	—	—	—	—	G	G	—	—	E	—	G	—	G	G	G	G
Ragweed, common	SA	—	—	G	G	G	G	G	F	G	—	G	G	G	—	—	G	G	G	—	G	G	—	E	G	G	F	G	G	G	G
Rocket, yellow	WA,B	—	—	—	F-G	F-G	F	G	G	G	—	G	G	—	G	—	G	—	—	—	P	G	—	E	—	G	—	G	—	—	G
Shepherd's-purse	WA	—	—	—	G	E-F	G	E-F	E-F	E	G	G	G	F	G	—	G	—	—	—	G	G	—	E	—	—	G	G	G	—	G
Sida spp.	A	—	—	—	—	—	—	—	—	F-G	—	—	—	—	—	—	G	—	—	—	G	—	—	—	—	—	—	G	—	—	—
Smartweed	SA	—	—	G	G	—	G	—	G	G	G	G	G	G	—	—	G	G	—	—	F-G	G	—	—	G	G	F-G	G	G	G	G
Sorrel, red	P	—	—	—	G	E	G	G	F	G	F	G	—	G	—	—	G	G	—	—	G	—	—	G	F-G	—	E	G	G	G	G
Speedwell, common	P	—	—	F	F	F	P	G	G	G	—	—	G	G	—	—	G	F	—	G	—	—	E	F-G	F-G	G	F-G	G	—	G	G
Speedwell, corn	WA	G	F-G	E	F-P	F	F-P	G	F-G	G	—	—	—	G	G	—	G	—	G	G	G-E	—	—	G	F-G	G	F-G	G	F-G	G	—
Speedwell, germander	P	—	—	F	P	F	P	G	G	G	—	—	—	G	—	—	G	—	—	—	—	—	—	F-G	F-G	G	F-G	G	—	G	—
Speedwell, purslane	WA	—	—	F	—	F	—	G	G	G	—	—	—	G	G	—	G	—	—	—	—	—	—	G	F-G	-G	F-G	G	—	G	—
Speedwell, thymeleaf	P	—	—	F	P-F	F	P	F	G	G	—	—	—	G	—	—	G	—	—	—	–	—	E	F-G	F-G	G	F-G	G	—	G	—
Spurge, prostrate	SA	—	—	E-F	F	G	G	G	F	G	F	G	—	—	—	—	G	—	G	—	E	G	G	E	F-G	E-F	E-F	G	G	G	G
Spurge, spotted	SA	—	F-G	E	F-P	G	G	G	F	G	F	G	—	—	—	—	G	—	G	—	E	G	G	E	F-G	F	E-F	G	G	G	G
Spurry, corn	P	—	—	—	F	—	F-G	F	F	G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	F	F	—	—	—	—
Spurweed (lawn burweed)	WA	G	G	F-G	F	E-F	E	E-F	F-G	E	F	—	—	—	G	—	G	—	—	G	G-E	—	—	E	F-G	E	E	G	—	G	—
Strawberry, Indian mock	P	—	—	—	P	F	E-F	F	P	E-F	—	—	—	—	—	—	G	—	—	—	—	—	—	G	—	—	—	—	G	—	G
Thistles	B,P	—	G	P	G	G	G	E-F	E-F	E	F	G	F	G	—	—	G	G	G	G	P-F	—	—	E	G	—	G	G	G	—	G

Weed	Lifecycle	Amicarbazone	Aminocyclopyrachlor	Atrazine/Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D +2,4-DP	2,4-D+MCPP+ dicamba	Carfentrazone	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Chlorsulfuron	Clopyralid	Flumioxazin	Fluroxypyr	Fluroxypyr + 2,4-D + dicamba	Imazaquin	Iodosulfuron+dicamba + thiencarbazone	Mesotrione	Metsulfuron	Pyraflufen-ethyl	Quinclorac	Quinclorac + 2,4-D + sulfentrazone + dicamba	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Sulfentrazone + 2,4-D + MCPP + dicamba	Sulfentrazone	Triclopyr + dicamba + sulfentrazone + 2,4-D
Vetch, common	WA, SA	—	E	E	G	G	G	G	F	G	—	—	—	G	G	—	G	G	G	—	E	—	G	G	G	G	E	G	—	—	—
Violet, Johnny-jumpup	WA	—	—	—	F-P	F-P	E-F	F-P	F	F-P	—	—	—	—	G	—	—	P-F	—	G	E	—	—	G	F	—	F-G	F-G	—	—	—
Violet, wild	P	—	G	—	F-P	F-P	E-F	F-P	F	F-P	—	G	F	—	—	—	—	—	—	G	—	—	—	F-G	F	F	F-G	F-G	F-G	G	G
Woodsorrel, creeping	P	—	—	F	P	P	G	P-F	P-F	P-F	—	G	—	—	—	—	G	—	—	—	F-G	—	—	G	F-G	F-G	F	—	—	G	G
Woodsorrel, yellow	P	—	—	F-G	P	P	G	F-P	F-P	F-P	—	G	—	P	—	—	G	—	—	G	E-F	—	—	G	F-G	--	E-F	—	—	G	G
Yarrow	P	—	—	—	F	F	E	G	G	E-F	—	G	G	—	—	—	G	—	—	—	F-G	—	—	G	F-G	G	—	G	G	—	G

[1]A = annual, B = biennial; P = perennial; SA = summer annual; WA = winter annual. [2]E = excellent (>89%) control; F = Fair to Good (70 to 89%), good control sometimes with high rates, however a repeat treatment 1 to 3 weeks later each at the standard or reduced rate is usually more effective, especially on perennial weeds; P = poor (<70%) control in most cases. Not all weeds have been tested for susceptibility to each herbicide listed.

POSTEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
Amicarbazone (0.044 to 0.175)	Xonerate 70WDG (1 to 4 oz)	Annual bluegrass, some broadleaf weeds (refer to the label), blanket crabgrass	All warm-season turfgrasses. Most cool-season turfgrasses established for at least 6 months.	For selective *Poa annua* control in creeping bentgrass, up to 4 applications spaced 7 days apart at 1 oz/acre each are used starting in late winter 2 to 4 following active Poa growth when temperatures are between 50 & 75F. On overseeded ryegrass, apply once regrowth resumes in late winter at 2 to 4 oz/acre. Repeat in 2 to 3 weeks. Repeat applications should be perpendicular to the initial, minimizing overlaps in at least 20 GPA. Adding a NIS is optional. Bentgrass areas can be reseeded 7 days following the last application. Treat only when temperatures are between 50 and 80 F. Three to 5 oz/acre may be used in St. Augustinegrass for blanket crabgrass control. Maxiumum use rate per season is 10 total oz/acre. Do not use mefluidide before or tank-mixed with amicarbazone. Read label closely before using on tall fescue or Ky. bluegrass. Triazolone herbicide.
2,4-D Amine (½ to 1 lb) See product label.	Several Brands	Many broadleaf weeds including matchweed, dandelion, pennywort, (dollarweed), wild garlic/onion, clover, chickweed, pearlwort, plantains, buttonweed. 2,4-DB alone will not adequately control leguminous weeds.	Bahiagrass Bermudagrass Kentucky bluegrass Ryegrass Tall fescue Zoysiagrass	Apply when weeds are young and actively growing. Repeat application in 10 to 14 days may be necessary for complete control. Use lower rates (0.5 lb ai/A) on `Tifgreen' and `Tifdwarf' Bermudagrass. Amine formulations should be used near ornamentals as volatile ester formulations have drift and volatility problems. Use low rate on centipedegrass, bluegrass, fescue, and carpetgrass. Not recommended on St. Augustinegrass. For hard-to-control perennial broadleaf weeds like buttonweed, white clover, henbit, and chickweed, formulations containing dicamba and a wetting agent will increase control. Repeat in 3 to 6 weeks. Low volatile ester formulations at the high rate are best for wild garlic/onion control. For this, apply in December and early March. Repeat in 3 weeks. Phenoxy herbicides.
2,4-D + 2,4-DP (0.7 to 0.9 each) See product label.	Weedone DPC (3 to 4 pts)			
dicamba (⅛ to ½ lbs) See product label.	Vanquish 4S (¼ to 1 pts) plus others	White clover, spurges, woodsorrel, dichondra, wild onions, henbit, knotweed, lespedeza, docks, + others		Avoid drift. Often effective on weeds not controlled by 2,4-D such as henbit, knotweed, clovers, lespedeza, docks, and woodsorrel, therefore, is used in many 2- and 3-way mixtures. Do not apply within the root zone of ornamentals as dicamba may leach and damage desirable plants. Repeat applications 10 to 14 days apart may be needed for complete control but may also result in some turf injury. Check label for use on greens; may be used on bentgrass tees & fairways. Use low rate on cool-season grasses. Benzoic acid herbicide.
dicamba (⅛ lbs) + 2,4-D, MCPP, MCPA, 2,4-DP (½ to ¾ lbs) &/or clopyralid, triclopyr, fluroxypyr, quinclorac, carfentrazone, sulfentrazone, pyraflufen	Many brands contain these mixtures. See product label for specific rates.	Same as for dicamba, also matchweed, clover, spurge, pennywort and others.		Same as for dicamba. Refer to product label for rates as herbicide ratios vary between brands. Use only on actively growing, non-stressed turf. Use low rates on cool-season grasses. Check label for use on golf greens. Mecomec 4 (¾ fl oz/1000 sq.ft.) and MCPP-4 amine (¾ fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (¾ fl oz/1000 sq.ft.), Bentgrass Selective (1 fl oz/1000 sq.ft.), and Trimec Bentgrass (1 fl oz/1000 sq.ft.) are MCPP + 2,4-D + dicamba formulations for greens, yellowing may occur.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
carfentrazone (0.0022 to 0.031 lbs)	QuickSilver 1.9 EC (0.55 to 2.1 fl oz)	Broadleaf weeds such as chickweed, white clover, dandelion, spurge, corn speedwell and plantain		Weed control is best when applied to small actively growing weeds (1-4 inches in height). This product is a contact herbicide with little to no residual activity. Can be used on centipedegrass and St. Augustinegrass (use low rate). For more advanced weeds and broader weed spectrum, this product can be tank mixed with 2,4-D, dichloprop, dicamba, MCPP, MCPA and atrazine. Use rates less than 1 fl oz/a when in combination with other herbicides. Maximum rate is 2.1 fl oz/a and a maximum of 3 broadcast applications per year per application site. Do not apply to hybrid bermudagrass or carpetgrass.
clopyralid (0.09 to 0.5 lbs) clopyralid + triclopyr (0.09-0.19 + 0.28-0.56)	Lontrel T&O 3L (¼ to 1.33 pts) Confront 3L (1 to 2 pts)	Broadleaf weeds, especially legumes such as clovers, vetch, and medic. Also for dock, speedwell, ragweed, and plantain.		Contains no 2,4-D. Safe on all warm- and cool-season turfgrasses but use high rates only on cool-season turfgrasses. Available for bentgrass fairways. Expect short-term phytotoxicity to warm-season grasses. Aster & legumes are especially susceptible. Not labeled for golf greens or tees or for residential turf. Do not use treated clippings for mulching and compost. Use only on grass mowed >½-inch. Picolinic acid herbicides.
fluroxypyr (0.125 to 0.5 lbs)	Spotlight 1.5L (0.66 to 2.66 pts)	Broadleaf weeds such as white/hop clover, ground ivy, chickweed, henbit, dandelion, plantain, purple deadnettle, woodsorrel, annual lespedeza and other broadleaf weeds		Weed control spectrum increases when tank-mixed with 2,4-D, MCPP, triclopyr, &/or dicamba. Note label rate restrictions for use on bentgrass, St. Augustinegrass, zoysiagrass and centipedegrass. Safe on most warm- and cool-season turfgrasses. Not labeled for golf greens or tees. Avoid treating to exposed suckers or exposed roots of trees and ornamentals. Do not use on newly seeded turfgrasses until they have been mowed at least twice. Pyridine herbicide. Bastion T, Battleship III, Chaser Ultra 2 Selective Herbicide, Escalade 4.4L and Escalade Low Odor 4.4L are pre-tank mixtures of fluroxypyr plus 2,4-D, 2,4-DP, MCPP, MCPA, triclopyr &/or dicamba.
fluroxypyr + triclopyr (0.5 to 1.0 lb)	Tailspin 1.33L (3 to 6 pts)	Numerous broadleaf weeds such as black medic, clover, woodsorrel, Vetch spp. plantain, Buttonweed, Veronica spp.	Cool-season turfgrasses only	See comments for fluroxypyr and triclopyr. Not for use on greens or tees. Controls many tough broadleaf weeds. Some injury to bentgrass may occur.
iodosulfuron + dicamba + thiencarbazone (0.11 to 0.21 lbs)	Celsius 68WDG (2.5 to 4.9 oz)	Broadleaf weeds like medic, geranium, clover, speedwell, dandelion, dollarweed, doveweed, burweed, spurge, others + carpetgrass.	Bermudagrass, Buffalograss, Centipedegrass, St. Augustinegrass, Zoysiagrass	Maximum yearly use rate of 7.4 oz/acre. Not for golf greens or collars or non-established turf. Do not use on desirable bahiagrass or cool-season turfgrasses. Do not use within 14 days of overseeding with ryegrass or sprigging with bermudagrass, or 30 days prior to seeding bermuda or zoysiagrass. For dallisgrass suppression, tank-mix (up to 0.11 oz) with foramsulfuron (Revolver 0.19L) at 2 fl oz per gallon water. Spot treat in late summer, repeat in 14 days.
foramsulfuron + halosulfuron + thiencarbazone-methyl (0.038 to 0.121 lb)	Tribute Total 61WDG (1 to 3.2 oz)	Early crabgrass, goosegrass plus many annual broadleaf weeds, sedges/kyllinga, ryegrass, fescue clumps, dallisgrass suppression,	Bermudagrass Zoysiagrass	For dallisgrass suppression, late summer (Sept. Oct.) treatments are best. Two applications at the high rate, 30 days apart are needed. Repeat for at least 1 additional year. Good soil moisture at the time of treatment is needed. Add MSO or NIS at 0.25% v/v. Sulfonylurea, sulfonylaminocarbonyl triazolinone.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
flumioxazin (0.375 lbs)	SureGuard 51WDG (12 oz/acre)	Winter annual broadleaf weeds, preemergence crabgrass	**Dormant** bermudagrass	A contact product for **dormant** bermudagrass for rapid nonselective winter annual broadleaf control with subsequent preemergence crabgrass control. Best winter annual broadleaf control is with early winter (Nov. & Dec.) applications. Best preemergence crabgrass control are with late winter applications. Allow 8 weeds after application before seeding or sodding. BroadStar 0.25G is a granular formulation. Dicarboximide herbicide.
penoxsulam (0.01 to 0.06 lbs)	LockUp + others	Broadleaf weeds including FL Betony, ground ivy, chickweed, oxalis, bittercress, pigweed, killings, broadleaf plantain,	most warm- & cool-season grasses except bahiagrass, fairways & roughs only	A granular postemergence broadleaf herbicides that will be custom blended by distributors. Depending on the formulation, the medium rate will be 0.03 lbs ai/acre applied twice, 4 weeks apart. Will be mixed with dicamba or 2,4-D + dicamba. Sapphire will be a liquid formulation of penoxsulam available only in the Western USA specifically for English daisy control.
pyraflufen-ethyl (0.00097 to 0.0055 lbs)	Octane 0.177L (0.7 to 4 oz)	Broadleaf weeds including dandelion, henbit, chickweed, clovers, knotweed, spurges, wild garlic and many others. Often an additive with other broadleaf herbicides to provide broader weed control spectrum and to hasten results.	Bentgrass Bermudagrass Centipedegrass Fine Fescue Kentucky bluegrass Ryegrass Tall Fescue Zoysiagrass	Safe on most warm- and cool-season turfgrasses. Use rate is 0.7 to 2.5 fl.oz./acre when in tank mix combinations with other broadleaf herbicides; 1 to 4 fl oz per acre if used alone. Weed control spectrum increases when tank-mixed with 2,4-D, dicamba, MCPA, triclopyr, fluroxypyr, and various combination of these. Do not apply to golf course tees or greens or to desirable carpetgrass or clovers. Do not use on newly seeded turfgrasses until they are established. Treated areas may be seeded or overseeded 1 day following application. Avoid drift onto ornamentals, trees, and shrubs. Professional use only.
sulfentrazone (0.125 to 0.375) sulfentrazone + imazethapyr (0.29 top 0.45 lbs)	Dismiss 4F, Spartan 4F (1/4 to 3/4 pts) Dismiss South 4F (9.5 to 14.4 oz)	Broadleaf weeds including dandelion, henbit, clovers, chickweed, spurges, speedwells, wild garlic and many others. Also suppresses and controls annual sedges, purple and yellow nutsedge and kyllingas	Bahiagrass Bentgrass Bermudagrass Buffalograss Carpetgrass Centipedegrass Fine Fescue Kentucky bluegrass Ryegrass Seashore Paspalum Tall Fescue Zoysiagrass	Safe on most warm- and cool-season turfgrasses. Maximum use rate on bentgrass, perennial ryegrass, fine and tall fescue is 4 fl oz/acre. Weed control spectrum increases when tank-mixed with 2,4-D and dicamba. Do not apply to golf course tees or greens. Do not apply directly to landscape ornamental or ornamental beds. Do not apply with surfactants unless compatibility test have been previously demonstrated as compatible and safe on grass type. Reseeding, overseeding, and sprigging can be performed three months after application due to product inhibiting establishment. Overseeding with ryegrass needs to be delayed 4 to 6 weeks after application but only if slight injury can be tolerated. Do not use on newly seeded turfgrasses until they have been mowed at least twice. Recommended that sod be established for at least 6 weeks before application and not within 3 months of a harvest. Spartan 4F is intended for sod and seed farms. Surge 2.18L is a pre-tank mixture of sulfentrazone plus 2,4-D, MCPP and dicamba. Echelon 4SC is a pre-tank mix of sulfentrazone + prodiamine. Dismiss South provides similar weed control as Dismiss with the addition of purple nutsedge.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
sulfentrazone + quinclorac (0.75 to 1.5)	Solitaire 75WG (1 to 2 lb)	Numerous broadleaf weeds, yellow nusedge, crabgrass, & foxtail. Refer to label for complete listing.	Bermudagrass, Bluegrass, Buffalograss, Centipedegrass, Perennial ryegrass, Seashore paspalum, Tall fescue, Zoysiagrass	Refer to comments for sulfentrazone and quinclorac. Not for use on golf greens, collars, or tees. A one month seeding restriction follows use. High rate is for warm-season turfgrasses.
carfentrazone + quinclorac (0.35 to 0.79)	Square One 70WDG (8 to 18 oz)	Numerous broadleaf weeds, yellow nusedge, crabgrass, & foxtail. Refer to label for complete listing.	All cool- and warm-season turfgrasses except St. Augustinegrass	Refer to comments for carfentrazone and quinclorac. Not for use on golf greens, collars, or tees. Can be used 1 day prior to or 7 days following seeding. High rates are for warm-season turfgrasses.
sulfentrazone + metsulfuron (0.134 to 0.413)	Blindside 66WG (3.25 to 10 oz)	Numerous broadleaf weeds esp. dollarweed, ground ivy, doveweed, wilt violet and some sedges (not Purple). Refer to label for complete listing.	Bermuda, Centipedegrass, Ky. bluegrass, St. Augustinegrass, Tall fescue, Zoysiagrass	Refer to comments for sulfentrazone and metsulfuron. Not for use on golf greens, collars, or tees. A one month seeding restriction follows use. Rate range for cool-season grasses is 3.25 to 6.5 oz product per acre and 6.5 to 10 oz per acre for warm-season grasses.
triclopyr alone, (½ to 1 lb) triclopyr +2,4-D (¼ to ½) + (½ to 1 lb)	Turflon Ester 4L (1 to 2 pts) Turflon II Amine (1 to 2 qts) Chaser 3L (1 to 2 qts)	Broadleaf weeds; partial bermudagrass & kikuyugrass suppression	Bahiagrass Bermudagrass Kentucky bluegrass Ryegrass Tall fescue Zoysiagrass	Use high rates only on cool-season turfgrasses. Even at low rates, expect short-term phytotoxicity to warm-season grasses. Repeat applications spaced 4 weeks apart are necessary for hard-to-control broadleaf weeds such as speedwell, parsley piert, violets, ground ivy, and woodsorrel. Newly established turf should be mowed 3 times before application. Picolinic acid herbicide.
MSMA/DSMA/CMA (1.0 to 2.0 lbs)	Several brands and formulations	Crabgrass, crowfootgrass, bahiagrass, nutsedge, dallisgrass, thin paspalum, alexandergrass, sandspur, annual broadleaf weeds	Bermudagrass	Repeat (2 to 4) applications at 7-10 day intervals are necessary, especially as weeds mature. Turf discoloration may occur, especially on `Tifdwarf' and `Tifgreen.' Use reduced rates on these cultivars. Apply when soil moisture is adequate. A nonionic surfactant is necessary but read the label for specific instructions regarding this. Multiple applications 5 to 7 days apart are required for dallisgrass and bahiagrass control. **Do not use on desirable St. Augustinegrass, centipedegrass or bahiagrass.** Use low rates on zoysiagrass. Of the three, CMA causes less discoloration to turfgrasses and should be the product of choice on cool-season grasses such as Ky. bluegrass, bentgrass fairways, and tall fescue. Organic arsenical herbicides. NOTE: The USEPA has cancelled all arsenical herbicides, effective in 2013.

POSTEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
MSMA (1.0 lbs) + metribuzin (⅛ to ¼ lbs)	Several brands + Sencor 75DF (0.16 to 0.33 lbs)	Crabgrass, goosegrass, dallisgrass, nutsedge, thin paspalum		The tank mix provides better goosegrass control than MSMA alone. Do not apply to turf under stress. Do not apply to tees, greens, or closely mowed turf. Do not add surfactant with this combination. Do not apply within the root zone of shallow rooted ornamentals. Some degree of short-term phytotoxicity can be expected, especially when applied during hot temperatures. Two applications 7 to 10 days apart may be necessary, especially with mature weeds. NOTE: The USEPA has cancelled all arsenical herbicides, effective in 2013.
MSMA (1.0 lbs) + foramsulfuron (0.039 lbs)	Several brands + Revolver 0.19L (27 oz)	Dallisgrass		Two strategies are used. One is to tank mix MSMA + Revolver at the indicated rates and apply twice, 10 days apart. The other is to alternate MSMA followed by Revolver 7 days later and then MSMA 7 days after the Revolver treatment. NOTE: The USEPA has cancelled all arsenical herbicides, effective in 2013.
metribuzin (¼ to ½ lb)	Sencor 75DF (0.33 to 0.66 lb)	Goosegrass, annual broadleaf weeds		Same as for MSMA + metribuzin above. Use higher rate on **dormant** bermudagrass for winter annual weed control. Use low rate on actively growing bermudagrass. Triazine herbicide.
diclofop-methyl (¾ to 1 lbs)	Illoxan 3EC (1 to 1.4 qts)	Goosegrass, ryegrass		For use only on golf courses. Young goosegrass plants are easiest to control. The high rate is needed for older plants. Larger, mature goosegrass will not be adequately controlled. Do not mow 24-36 hours after applying. Control takes 2-3 weeks. May cause temporary (7 to 10 days) phytotoxicity. Treat only well established and actively growing turf. Wait 6 weeks before overseeding after the last application. Tank mixing with MSMA, 2,4-D, or metribuzin increases turf burn and may reduce weed control. Restricted Use Pesticide. Aryl-oxy phenoxy herbicide.
ethofumesate (1 to 1½ lb)	Prograss 1.5 EC (2.66 to 4 qt) Prograss 4 SC (2 to 3 pts)	Annual bluegrass, chickweed		Provides annual bluegrass control in dormant bermudagrass overseeded with perennial ryegrass. The first application at 2.66 qts/a should be 30 to 45 days following overseeding. The second should be 21 to 28 days later. **Do not apply after January 15**. May cause premature dormancy if green bermudagrass is treated. Not labeled for golf greens. May injure poorly rooted, shaded or wet bentgrass fairways sites. Unclassified herbicide.
pronamide (1 to 1½ lbs) metsulfuron (0.02 lb) rimsulfuron (0.0075 to 0.03) foramsulfuron (0.013 to 0.039) trifloxysulfuron (0.005 to 0.015)	Kerb 50W (2 to 3 lbs) Manor/Blade 60 DF (1 oz) TranXit 25DG (0.5 to 2 oz) Revolver 0.19L (8.8 to 27 oz) Monument 75 WG (0.11 to 0.33 oz)	Annual bluegrass, ryegrass clumps, *Poa trivialis*, spring transition, various broadleaf weeds		Use only on bermudagrass or possibly zoysiagrass. Refer to the label for timing intervals of applications prior to overseeding. Do not apply on or up-slope to desirable bentgrass or overseeded turf as these may run. Movement is encourage when saturated soils are treated and/or heavy (>0.25 in) rainfall occurs within 48 hours of application. Time required for control increases as weeds mature, therefore apply in late fall for optimum results. For slow (3 to 6 weeks) transition, use the low rate of each herbicide listed. For quick transition (1 to 2 weeks), use TranXit, Revolver, Katana, or Monument at the high rate in mid-May. Treated plants do not show herbicide symptoms until air temperatures are consistently above 60F. Pronamide is a Restricted Use Pesticide. Amide and sulfonylurea herbicides.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
flazasulfuron (0.012 to 0.047)	Katana 25DG (0.75 to 3 oz)			
rimsulfuron (0.015 to 0.0625 lbs)	TranXit GTA 25WSP (1 to 4 oz)	Annual bluegrass		Apply 7 to 10 days prior to overseeding. Also used for non-selective control of annual bluegrass and ryegrass in non-overseeded bermudagrass. Treat in fall to early winter for best results. Sulfonylurea herbicide.
simazine (1 lb)	Princep T&O 4L (1 qt)	Annual bluegrass, most winter annual broadleaf weeds		Do not exceed use rates. For winter annual weed control, apply 1 qt/A in early fall (after Oct. 15) and repeat in early winter. Do not apply on or upslope to desirable overseeded turf &/or golf greens. Do not use on bermudagrass during spring 'green-up' or summer unless temporary yellowing and stunting of bermudagrass can be tolerated. Triazine herbicide.
foramsulfuron (0.013 to 0.039)	Revolver 0.19L (8.8 to 27 oz)	All cool-season grasses including ryegrass, fescue, bluegrasses, etc., henbit, goosegrass		Controls all cool-season grasses, and for transition, plus henbit and goosegrass (at higher rates). Bermudagrass and zoysiagrass (Meyer) are tolerant. Labeled for all commercial situations such as golf courses, athletic fields, lawns, and sod farms. Refer to the label for timing intervals of applications prior to overseeding. Sulfonylurea herbicide.
bispyribac-sodium (0.022 to 0.132 lb)	Velocity 17.6SC (6 to 12 oz)	Selective Poa annual and Poa trivialis control in overseeded ryegrass and bentgrass fairways	Bermudagrass fairways overseeded with ryegrass, Bentgrass fairways	Apply between Feb. 1 and March 15 when daytime/nighttime temperatures are 70/50 F at 6 to 12 oz/acre in 25 to 50 gallons of water. Use higher labeled rates as Poa matures. Higher rates, however, may cause short-term ryegrass chlorosis. Reapply in 21 to 42 days if Poa regrowth is observed. Treated ryegrass should be overseeded before Oct. 15th at ≥300 lbs seed/acre. No surfactant or adjuvants are needed. On bentgrass fairways, apply 2 to 6 oz/acre weekly in spring/summer only when the bentgrass is actively growing. For Poa trivialis control, apply 4 to 9 oz/acre weekly. For all scenarios, use lower rates when higher weed populations are present to prevent voids from developing. Pyrimidinyl benzoic acid family.
glyphosate (0.375 lbs) glyphosate + diquat (3.55 to 6.7 lbs) glufosinate (¾ lbs) diquat (¼ to ½ lbs) clethodim (0.25 lbs) metribuzin (0.25 to 0.5)	Roundup Pro 4L (¾ pt) QuickPRO 76 WG (4.5 to 9 oz) Finale 1SC (3 qts) Reward 2L (1 to 2 pts) Envoy 0.94 EC (34 oz/a) Sencor 75 Turf (0.33 to 0.67 lbs)	Annual bluegrass, Winter broadleaf weeds	**Dormant** bermudagrass	Apply only to fully **dormant** bermudagrass (no green stolons or leaf tissue visible, typically January 15 to 25 in SC). Apply glyphosate in 5 to 20 GPA. Do not apply to desirable green turf. Add a nonionic surfactant to diquat and clethodim at 0.25% v/v (1 qt/100 gal). Do not apply to desirable cool-season turf species. Envoy will not control broadleaf weeds. The Envoy label is a state 24 (c) Special Local Need Label for sod production. Use QuickPRO only in areas where bermudagrass and bahiagrass are desirable ground covers. Rates greater than 9 oz/a may result in injury or delayed green-up in highly maintained areas. Apply in 10 to 80 gallons of water per acre Use lower rate for annuals and higher rate for perennials.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
asulam (2.0 lbs)	Asulox 3.34L (5 pts)	Crabgrass, goosegrass, sandspur	Bermudagrass, St. Augustinegrass sod production	Do not apply to freshly mowed turf or turf under stress. On Bermudagrass use on `Tifway' only. Do not use a surfactant. Asulox is for professional applicators only and only for sod production when used on St. Augustinegrass. Carbamate herbicide.
atrazine/simazine (1 to 2 lbs) atrazine + bentazon (½ to ¾ lbs)	Several Brands. Read the label for rates Prompt 5L (1.8 to 2.4 pts)	Many broadleaf weeds including matchweed, oxalis, pennywort, Florida betony and some annual sedges.	Centipedegrass St. Augustinegrass Zoysiagrass	For hard to control weeds, make the first application in late fall and follow with another 4 to 6 weeks later. If weeds persist, follow atrazine applications with dicamba in 4 to 6 weeks. Some turf injury can be expected with this. Two applications of atrazine are allowed per year. Effectiveness will be reduced as weeds mature. Do not apply within the root zone of ornamentals. Triazine herbicides. Prompt 5L provides additional activity on hard-to-control weeds.
metsulfuron (0.01to 0.04 lb)	Manor 60DF Blade 60DF Escort 60DF (¼ to 1 **oz**)	Bahiagrass, foxtails, broadleaf weeds including chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic	Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	Note the low use rate. As weeds mature, the rate must be increased. A nonionic surfactant at 0.25 % by volume (1qt/100 gal) increases control. Do not use beneath desirable trees or ornamentals or on desirable 'Pensacola' bahiagrass. Escort is labeled for 'rough' turf such as roadsides, utility lines, and railroads while Manor and Blade are for fine turf including bermudagrass, St. Augustinegrass, zoysiagrass, centipedegrass, Ky. bluegrass and fine fescue. Do not apply to desirable tall fescue or ryegrass. Some bahiagrass varieties ('Common,' 'Argentine,' & 'Paraguayan') are not completely susceptible. Sulfonylurea herbicide.
dicamba (⅛ to ¼ lbs)	Vanquish 4S (¼ to ½ pts)	White clover, spurge, woodsorrel		Avoid drift. Do not apply within the root zone of ornamentals. Use low rates on St. Augustinegrass. Treat when temperatures are #80 F to minimize turf damage. Benzoic acid herbicide.
dicamba + 2,4-D, 2,4-DP, MCPA, and/or MCPP (⅛ + ¼ to ½ lbs)	Several brands contain these mixtures	White clover, spurge, woodsorrel, pennywort plus other broadleaf weeds.		Observe same precaution as dicamba above. Refer to product label for rates. A second application on centipedegrass 7-14 days later may be needed. Use low rates on St. Augustinegrass. A tank mix of atrazine at 1 lb ai/A + 2,4-D & dicamba at 0.2 lb ai/A each provides good control with minimum turf damage when temperatures are #80 F. Phenoxy herbicides. All 2,4-D containing formulations are limited to a maximum number of 2 broadcast applications per treatment site per y ear.
bromoxynil (\ to ½ lb)	Buctril 2L (1 to 2 pts)	Many young broadleaf weeds	Bentgrass Bermudagrass Ky. bluegrass St. Augustinegrass Tall fescue	Labeled only for non-residential turf, seed and sod production. Contact herbicide, therefore, thorough coverage is necessary. Safe on seedling or sprigged turf with less drift potential than phenoxy herbicides. Tank mixing with 2,4-D, dicamba, &/or MCPP will provide increased control but should be used only on established turf. May also be used on bermudagrass, bentgrass, Ky. bluegrass, tall fescue, & ryegrass but not centipedegrass. Restricted Use Pesticide. Nitrile herbicide.
sethoxydim (0.19 to 0.28 lbs)	Vantage 1L, Segment 1L (1½ to 2¼ pts)	Crabgrass, goosegrass and other annual grasses suppression of dallisgrass	Centipedegrass Fine Fescue	Apply before weeds mature. Repeat applications are necessary to suppress bermudagrass or bahiagrass. Safe on centipedegrass seedlings after the third mowing. Vantage has oil concentrate pre-added. Cyclohexendione herbicide.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
clethodim (0.125 to 0.25 lbs)	Envoy 0.94 EC (17 to 34 fl.oz.)	Common bermudagrass, other grasses such as johnsongrass, barnyardgrass	Centipedegrass Sod Production	This is a 24 (c) Special Local Need Label. Add non-ionic surfactant at 0.25% v/v (1 qt/100 gal). Apply only to actively growing, non-stressed turf. Repeat application 3 to 4 weeks apart may be necessary to suppress bermudagrass. Some discoloration to centipedegrass will occur at the higher rate. Cyclohexendione herbicide.
imazapic (0.063 to 0.125 lb)	Plateau 70 DG (1.43 to 2.86 oz or 1 to 2 water soluble packs)	Bahiagrass, crabgrass, Yellow and Purple nutsedges, annual sedge & *Kyllinga* species		For centipedegrass grown as sod, on golf courses, and other recreation areas. Not for use on home lawns. The highest rate may cause turf reddening. Repeat applications may be needed for tough to control perennial weeds such as bahiagrass. See label for mixing instructions of water soluble packs.
chlorsulfuron (0.05 to ¼ lb)	Corsair 75DF, TFC 75DF (1 to 5.3 oz)	Broadleaves, wild garlic, tall fescue, perennial ryegrass in bentgrass fairways	Bermudagrass Bahiagrass Bentgrass fairways Fine fescue Kentucky bluegrass	Especially effective for tall fescue clump control. Spot treat tall fescue & perennial ryegrass when in established Kentucky bluegrass, bentgrass fairways, or fine fescue using a hand-held sprayer delivering 1 gallon of spray solution per 1,000 sq.ft. Spray only to wet the tall fescue blades. Avoid excess-application. Repeat treatment may be needed in 60 days. Slow acting. Do not use underneath desirable shrubs or trees. Not for use in sod production. Read and follow all label directions before use. Sulfonylurea herbicide.
ethofumesate (3.0 lb)	Prograss 1.5EC (2 gal) Prograss 4SC (3 qts)	Common bermudagrass control/suppression	St. Augustinegrass	Timing is critical. Spring applications should start in the Carolinas in mid March. Repeat in 30 days. Tank mixing with atrazine or simazine at 2 lb ai/A significantly increases suppression. Temporary St. Augustinegrass stunting may result. Do not overlap. Unclassified herbicide.
fenoxaprop (0.06 to 0.17 lb)	Acclaim Extra 0.94 L (8 to 23 oz)	Annual weedy grasses, bermudagrass suppression	Annual bluegrass Bentgrass fairways Fine fescue Kentucky bluegrass Perennial Ryegrass Tall fescue Zoysiagrass	Young, actively growing weeds are easiest to control. Apply in late spring or early summer to actively growing weedy grasses. Do not apply to moisture- or heat-stressed turf or weeds. Repeat in 2 to 3 weeks for complete control. Control is reduced if applied within 14 days after a broadleaf herbicide. For bermudagrass suppression in tall fescue or zoysiagrass, begin treatment after spring green-up of the bermudagrass at 1½ pts/A and repeat at 3-week intervals. Seedlings should be at least 4 weeks old before treatment. Do not mow for 24 hrs after application, nor tank-mix with phenoxy herbicides. Not labeled for golf greens. The addition of triclopyr ester (Turflon Ester) at 1 pt/a may increase control but should not be used on warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.
fluziafop-butyl (0.05 to 0.1 lbs)	Fusilade T&O II 2EC (3 to 6 oz)	Annual grasses, bermudagrass suppression	Tall fescue Zoysiagrass	Add nonionic surfactant at 0.25% v/v. Begin treatment on zoysiagrass at 3 to 4 fl.oz./A in early June. Repeat application every 4 weeks. On tall fescue, make first application in spring after bermudagrass green-up at 5 to 6 fl.oz./A and a second application in early fall. Turf discoloration may occur for up to 14 days after application. Do not apply to tall fescue during hot, dry weather. Adding triclopyr ester (Turflon Ester) at 1 pt/a may increase control but should not be used on warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.

POSTEMERGENCE HERBICIDES (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
quinclorac (0.75 lb)	Drive 75 DF (1 lb) Drive XLR8 1.5L (0.5 gal)	Crabgrass, signalgrass, torpedograss, barnyardgrass, foxtail, kikuyugrass, broadleaf weeds such as pennywort, speedwells, dandelion, black medic, white clover, violets	Annual bluegrass Annual ryegrass Bentgrass fairways Buffalograss Common bermuda Kentucky bluegrass Perennial ryegrass Tall fescue Zoysiagrass	At least 2 application 3 weeks apart are needed for control of perennial weeds. Multiple applications will be needed for torpedograss/kikuyugrass control. Good soil moisture should be present before treatment. Creeping bentgrass, hybrid bermudagrass, & fine fescue have intermediate tolerance. May be applied before, at , and during seedling emergence of bermudagrass, tall fescue, and zoysiagrass. Do not apply to desirable bahiagrass, centipedegrass, St. Augustinegrass, or dichondra. Tank mixing with N or Fe may lessen turf discoloration. Add a crop oil concentrate (2 pts/a) or methylated seed oil (1.5 pts/a) to increase performance but not until 28 days after seedling emergence. Not labeled for golf greens or collars. Avoid application and drift onto ornamentals. Quinolinecarboxylic Acid herbicide.
mesotrione (0.125 to 0.25 lb) topramezone (0.11 to 0.044 lb)	Tenacity 4L (4 to 8 oz) Pylex 2.8 SC (0.5 to 2.0 oz)	Bentgrass, crabgrass, goosegrass, foxtail, nimblewill, lovegrass, barnyardgrass, yellow nutsedge, Buttercup, buckhorn plantain, carpetweed, clover, chickweed, dandelion, dock, FL betony & pusley, ground ivy, henbit, lawn burweed, oxalis, pigweed, speedwell, Canada thistle, wild violet.	Ky Bluegrass, Tall fescue, Perennial ryegrass, Centipedegrass, Fine fescue, St. Augustinegrass	For golf, sod, and commercial properties. Tenancity provides selective control of bentgrass in Ky. bluegrass and other turfgrass listed when treated twice, 3 weeks apart. Both products control nimblewill, crabgrass, goosegrass and other grasses if treated before seedhead emergence. Also used prior to seeding listed cool-season turfgrasses for preemergence crabgrass control. Use low rate on St. Augustinegrass sod. Add a nonionic surfactant at 0.25% v/v. Bentgrass, bermudagrass, zoysiagrass, Poa annua, kikuyugrass, and seashore paspalum have low tolerance. For tufted lovegrass control in zoysiagrass sod production, use 2 oz/acre Tenacity plus 0.25 lb ai/acre atrazine twice, 10 days apart. For dallisgrass, Japanese Stiltgrass, and nimblewill suppression with Pylex, apply 1 to 1.33 fl oz/acre with 3 applications 3 to 4 weeks apart. Pylex can be used on taller-mowed bentgrass at 0.5 to 1 oz/acre to control crabgrass/goosegrass and to suppress bermudagrass. Short term turfgrass phytotoxicity (whitening) may occur with either product. Mix with triclopyr ester to reduce this whitening & to increase grassy weed control. Triketone (callistemone) herbicide family.
mecoprop (MCPP) alone (½ to 1 lb) or plus 2,4-D and dicamba	See comment	Postemergence annual broadleaf weeds	Bentgrass	Same as for dicamba. Refer to product label for rates as herbicide ratios vary depending on brands. Use only on actively growing, non-stressed turf. Check label for use on golf greens. Mecomec 4 (¾ fl oz/1000 sq.ft.) and MCPP-4 amine (¾ fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (¾ fl oz/1000 sq.ft.), Bentgrass Selective (1 fl oz/1000 sq.ft.), and Trimec Bentgrass (1 fl oz/1000 sq.ft.) are MCPP + 2,4-D + dicamba formulations for greens. Do not apply to stressed greens. Phenoxy herbicides.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
paclobutrazol (0.25 to 0.375)	Turf Enhancer 50WP (0.5 to 0.75 lb/acre or 0.28 oz/1000 ft^2) Trimmit/Turf Enhancer 2 SC (16 to 24 oz/acre or 0.55 fl.oz/1000ft^2	*Poa annua* var. *reptans* (perennial biotype) conversion/ management in bentgrass golf greens		Root absorbed. Apply 30 days apart at higher rate 2 or 3 times in fall (September to early Dec.) plus 2 or 3 times in very early spring (late Feb. to mid April) when bentgrass is actively growing. Increased Poa control often occurs at the lower rate if a sterol inhibitor fungicide (DMI) such as Banner Maxx at 1 oz/1000 sq.ft. is applied 2 weeks following each paclobutrazol applications. Do not use if *Poa annua* populations exceed 70% as severe stand thinning or discoloration may result. Do not apply within 4 weeks of anticipated cold or hot weather. **Note:** This program is designed as a gradual transition or conversion from *Poa annua* to bentgrass. Repeat applications over several years will be required. Treated Poa will appear noticeably lighter green in color while treated bentgrass may appear 'grainy.' Apply only to actively growing bentgrass. Type II PGR.
trinexapac-ethyl (0.05 to 0.11)	Primo MAXX 1L (6 to 14 oz/acre or 0.14 to 0.32 fl.oz./1000ft^2)	*Poa annua* var. *reptans* (perennial biotype) conversion/ management in bentgrass golf greens		Foliar absorbed. The 6 oz/a rate is for golf greens while 11 oz/a is for fairways. A 7 oz/a rate may be used for bentgrass/*Poa annua* mixed greens while up to 14 oz/a can be used if conversion to bentgrass is desired & temporary discoloration can be tolerated. Good golf green quality has been maintained with 2 to 6 oz/1000 ft^2 every 2 to 4 weeks. Type II PGR.
siduron (11 to 22 lbs)	Tupersan 50WP (22 to 44 lbs)	Postemergence bermudagrass suppression		Granular formulations also are available. Used alone or in combination with ethofumesate (Prograss) or flurprimidol (Cutless). Control is generally best with spring (March + April + May + early June) and fall (late September + October + November) applications when the bentgrass is actively growing and the bermudagrass is not. Substituted urea herbicide.
ethofumesate + flurprimidol (see remarks)	Prograss 1.5EC + Cutless 50W (see remarks)	Postemergence bermudagrass suppression;		Apply 1st application (March-April) when bermudagrass is breaking dormancy at 1.5 (Prograss) + 0.75 (Cutless) lb ai/A; 2nd application 6 weeks later at 0.38 + 0.19 lb ai/a followed by 3rd and 4th applications spaced 3 weeks apart. Repeat applications are needed to maintain suppression. Approximately 30% bentgrass discoloration & thinning may follow high rate but should recover within 3 weeks.
carfentrazone (0.031 to 0.1)	Quicksilver 1.9 L (2.1 to 6.7 oz)	Postemergence moss suppression (*Bryum argenteum*)		Reduce surface moisture and shade as these favor moss persistence; raise the mowing height. Quicksilver at 6.7 oz/acre at 100 GPA when air temperatures are <85F provides excellent silver thread moss suppression with good bentgrass/*Poa annua* tolerance. Do not apply to desirable hybrid bermudagrass. Repeat this every 2 weeks until complete control occurs. Other, but less effective chemical options include Daconil Weather Stik 6L at 4 to 8 oz product per 1000 sq.ft. in 5 to 10 gallons of water; Apply when temperatures are >80F (preferably, >85F); Ironizer (4-0-0-18) granular at 225 oz per 1000 sq.ft.; Iron sulfate alone at 32 oz/1000 sq.ft. or combined with ammonium sulfate at 48 oz/1000 sq.ft. Only use iron containing products when temperatures are cool. Other contact, burn-down products may also work.

POSTEMERGENCE HERBICIDES (***Refer to Herbicide Label for Specific Turf Species Use Listing***)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
ethofumesate (0.5 to 0.75 lb)	Prograss 1.5EC (3 to 4 pts) Prograss 4SC (1 to 1.5 pts)	Annual bluegrass	Creeping bentgrass fairways & Ky. bluegrass fairways & roughs; Tall fescue	Treat young (1 to 5 leaf stage) weeds in fall. Use lower rate on closer mowed turf. Will not adequately control mature plants or perennial biotypes. Multiple applications spaced 3 weeks apart may be necessary. Do not use on turf less than 8 weeks old nor reseed within 6 weeks after application. Bentgrass that is shaded, poorly drained (wet), and cold often experience herbicide damage. Unclassified herbicide.

[1]**Comments:** Active only on emerged, visible weeds. Best results occur when weeds are young. Temperatures above 85-90EF may result in phytotoxicity (yellowing) to the turf. Repeat applications may be required for acceptable control. These should be timed 10 to 14 days apart. Do not mow within 48 hrs after application for most chemicals. Most postemergence herbicides require the use of a spreader-sticker, adjuvant, crop oil, or wetting agent. Read the label before adding these as many herbicides are pre-packaged with them already added. Most postemergence herbicides need to dry on the leaf surface before irrigation or rainfall occurs.

Relative Sedge Control and Turf Tolerance to Various Herbicides (*Refer to Herbicide Label for Specific Turf Species Use Listing*).

Herbicide (trade names)[1]	Sedge Control					Turf Tolerance (excluding greens)									
	Annual Sedge	Purple Nutsedge	Yellow Nutsedge	Annual Kyllinga	Perennial Kyllinga	Bermudagrass	Bentgrass	Bluegrass, Ryegrass	Centipedegrass	St. Augustinegrass	Seashore Paspalum	Bahiagrass	Zoysiagrass	Kikuyurass	Tall Fescue
Preemergence Control															
Dimethenamid (Tower)	G[2]	F-G	G	G	F-G	S	NR	S	NR	NR	NR	NR	S	NR	S
Metolachlor (Pennant Magnum)	G	P	G	F-G	P	S[3]	NR	NR	S	S	NR	S	S	NR	NR
Oxadiazon (Ronstar 2G)	G	P	P	F	P	S	NR	S	NR	NR	NR	NR	S	NR	S
Postemergence Control															
Bentazon (Basagran T&O)	G	P	G	F-G	F-G	S	S-I	S	S	S	NR	S	S	NR	S
Imazaquin (Image)	G	G	F	G	G	I-S	NR	NR	I	I	NR	NR	S	NR	NR
Imazapic (Plateau)	G	G	G	--	--	I-S	NR	NR	S	NR	NR	NR	NR	NR	NR
Imazosulfuron (Celero)	G	G-E	G-E	G	F	S	S	S	S	S	NR	NR	S	NR	S
Halosulfuron (Sedgehammer)	G	G-E	G-E	G	F-G	S	S	S	S	S	S	S	S	S	S
MSMA/DSMA/CMA	G	P-F	F	G	G	S-I	I	NR	NR	NR	NR	NR	S-I	NR	I-S
Image + MSMA/DSMA	G	G	G	G	G	S-I	NR	NR	NR	NR	NR	NR	S-I	NR	NR
Sulfentrazone (Dismiss)	G	P-F	F	F	F	S	S	I-S	S	NR	S	S	S	S	S
Sulfentrazone + imazethapyr (Dismiss South)	G	G	G	G	G	S	NR	NR	S	NR	NR	S	S	S	NR
Sulfosulfuron (Certainty)	G	G	G	G	G	S	NR	NR	S	S	NR	S	S	S	NR
Trifloxysulfuron (Monument)	G	G	G	G	G	S	NR	NR	NR	NR	NR	NR	S	NR	NR

[1]Repeat applications are necessary for complete control from all herbicides. This interval is from 5 days for MSMA/DSMA and 3 to 5 weeks for Certainty, Celero, Sedgehammer, Monument, or Image.

[2] E = excellent (>89%) control; F = Fair to Good (70 to 89%), good control sometimes with high rates, however a repeat treatment 1 to 3 weeks later each at the standard or reduced rate is usually more effective; P = poor (<70%) control in most cases.

[3]S=Safe at labeled rates; I=Intermediate safety, use at reduced rates; NR=Not Registered for use on and/or damages this turfgrass; D=Dormant turf only.

These are relative rankings and depend on many factors such as environmental conditions, turfgrass vigor or health, application timing, etc., and are intended only as a guide.

POSTEMERGENCE SEDGE CONTROL (*Refer to Herbicide Label for Specific Turf Species Use Listing*)[1]

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
bentazon (1 to 2 lb)	Basagran T&O 4L (2-4 pts) Lescogran 4L (2-4 pts)	Yellow nutsedge, globe sedge, annual sedge and many annual broadleaf weeds	Bahiagrass Bermudagrass Centipedegrass Fine fescue Kentucky bluegrass St. Augustinegrass Tall fescue	Apply when yellow nutsedge is actively growing under good soil moisture conditions. Thorough spray coverage is necessary as will repeat applications in 10 to 14 days. Will not satisfactory control purple nutsedge. Not labeled for golf greens. A pre-packaged combination of bentazon and atrazine is available as Prompt. Benzothiadiazole herbicide.
halosulfuron (0.03 to 0.06 lb)	Sedgehammer 75WP (0.66 to 1.3 oz) Sandea 75WP (0.66 to 1.3 oz)	Most nutsedges and kyllinga species; groundsel, purslane		Note the low use rate, also labeled on paspalum. Add 0.5% nonionic surfactant (½ gal/100 gal). Nutsedges should be actively growing when treated. Spot treat with 0.9 grams Sedgehammer 75WP + a fl oz surfactant per gallon of water. Repeat application(s) 3 to 4 weeks apart will be needed for complete control. Not labeled for golf greens. **Note:** Sandea is for Turfgrass Sod and Seed Farms only. Sulfonylurea herbicide.
MSMA (2.0 lbs)	Several brands	Yellow nutsedge, annual (water) sedge	Bermudagrass Zoysiagrass	Repeat application will be needed 10 to 14 days apart. Use a wetting agent. Some turf discoloration can be expected. Organic arsenical herbicide.
sulfosulfuron (0.035 to 0.059) trifloxysulfuron (0.015 to 0.026)	Certainty 75WDG (0.75 to 1.25 oz) Monument 75DF (0.33 to 0.56 oz)	Most sedges & kyllinga species Also controls certain broadleaves and annual bluegrass		Repeat application may be needed 3 to 4 weeks after the initial for perennial plants. Will injure/control cool-season turfgrass including tall fescue. Add 0.25% v/v nonionic surfactant. Sulfosulfuron is safe on all major warm-season turfgrasses. Refer to specific label for additional tolerant turfgrasses and susceptible weeds. Sulfonylurea herbicide.
imazaquin 0.375 to 0.5 lb)	Image 1.5LC (2-2.5 pts)	Purple nutsedge, kyllinga, sandspur, wild garlic, some broadleaves	Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	Add a nonionic surfactant at 0.25% (1 qt/100 gal). Do not apply to newly seeded, sodded, or sprigged areas or **during spring transition**. Not labeled for use on bahiagrass, cool-season grasses, or golf greens. Repeat applications may be required as weeds mature. For wild garlic/onion control, apply at 2 pts/A during December followed with b to 1a pt/A in early March. Treated turf may have a compacted growth habit and inhibited seedhead formation. Imidazolinone herbicide.
imazaquin (0.38 lb) + MSMA (1 to 2 lbs)	Image 1.5LC (2 pts) + Several Brands	Most sedges and kyllinga species.	Bermudagrass	Same as for MSMA and imazaquin. Repeat applications may be required as weeds mature.
imazosulfuron (0.38 to 0.66 lb)	Celero 75WDG (8 to 14 oz)	Most sedges and kyllinga species + some broadleaves	Bermudagrass, Bentgrass, Bentipdegrass, Fine/tall fescue, Ky. bluegrass, Perennial ryegrass, St. Augustinegrass, Zoysiagrass	Repeat application 21 after the initial may be required for complete control. Do not treat wet turf or to golf course putting greens. Add NIS at 0.25% v/v. Sulfonylurea herbicide.

sulfentrazone (0.125 to 0.375)	Dismiss 4L (4 to 12 oz)	Suppresses and controls annual sedges, yellow nutsedge and kyllingas. Also control various broadleaf weeds.	Bahiagrass Bentgrass Bermudagrass Buffalograss Carpetgrass Centipedegrass Fine Fescue Kentucky bluegrass Ryegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	Add a nonionic surfactant at 0.25 % v/v (1 quart per 100 gallons of spray solution). Good coverage is needed for optimum control. Rates less than ¾ pints/acre will generally suppress most sedges for at least 60 days requiring a second application 5 weeks following the initial. Temporary discoloration may results due to use of surfactant. Test compatibility of surfactant before use. Several combination products containing sulfentrazone are available.
sulfentrazone + imazethapyr (0.29 to 0.45 lbs)	Dismiss South 4L (9.5 to 14.4 oz)	Same weeds as Dismiss plus purple nutsedge and others.	Bahiagrass Bermudagrass Buffalograss Centipedegrass Kikuyugrass Zoysiagrass	Use only on well established labeled turfgrass species. Do not use with 4 weeks of reseeding, overseeding, or sprigging. Do not use on golf course greens or tees or directly to landscape ornamentals or ornamental beds. Suggested split application rate options are 9.5 oz followed by 4.9 oz/acre or 7.2 oz followed by 7.2 oz/acre 35 days after the initial for both. Aryl-triazinone + imidazolinone herbicide.

[1]Presence of a herbicide in this listing does not constitute a recommendation. Trade names are used with the understanding that no endorsement is intended or no criticism is implied of similar products not mentioned. All chemicals should be used in accordance with the manufacturer's instructions.
The following conversions may be useful. Gal/acre x 2.938 = oz/1000 ft^2; Qt/acre x 0.7346 = oz/1000 ft^2; Pint/acre x 0.3673 = oz/1000 ft^2; lbs/acre x 0.02296 = lb/1000 ft^2.

Managing Herbicide Resistant Weeds

Bert McCarty

Herbicide resistant weeds in turf, such as *Poa annua*, spurges, goosegrass, and crabgrass, are becoming more prevalent,. Fortunately, this can be contained if prudent action is taken. The following table summarizes the main herbicides used in turf including their timing (Pre- vs Post-emergence), their mechanism of action within plant (how they control them), and the various active ingredients. Rotating between and tank-mixing herbicides with different mechanisms of action are keys to delaying or preventing herbicide resistant weeds from dominating a population.

Timing	Mechanism of Action	Active Ingredient (Trade Name Example)
PRE	Cellulose biosynthesis inhibition	Indaziflam (Specticle)
	Mitotic (microtubule) inhibition	Benefin (Balan)
		Dithiopyr (Dimension)
		Oryzalin (Surflan)
		Pendimethalin (Pendulum)
		Prodiamine (Barricade)
		Trifluralin (Treflan)
	Lipid biosynthesis inhibition	Bensulide (Bensumec)
	Long-chain fatty acid inhibition	Dimethenamid (Tower)
		Metolachlor (Pennant)
PRE/POST	Mitotic (microtubule) inhibition	Pronamide (Kerb)
	Photosystem II inhibition – Site A	Atrazine (Aatrex)
		Metribuzin (Sencor)
		Simazine (Princep)
	Lipid biosynthesis inhibition	Ethofumesate (Prograss)
	Protoporphyrinogen oxidase (PPO) inhibition	Flumioxazin (SureGuard)
		Oxadiazon (Ronstar)
POST	Acetolactate synthase (ALS) inhibition	Bispyribac-sodium (Velocity)
		Chlorsulfuron (Corsair)
		Flazasulfuron (Katana)
		Foramsulfuron (Revolver)
		Imazaquin (Image)
		Metsulfuronn (Manor)
		Rimsulfuron (TranXit)
		Sulfosulfuron (Certainty)
		Thiencarbazone-methyl
		Trifloxysulfuron (Monument)
	Acety CoA Carboxylase (ACCase) inhibition	Clethodim (Envoy)
		Fenoxprop (Acclaim Extra)
		Fluzaifop (Fusilade)
		Sethoxydim (Vantage)
	Auxin agonist (growth regulators)	Clopyralid (Lontrel)
		2,4-D (Weedone)

Timing	Mechanism of Action	Active Ingredient (Trade Name Example)
		Dicamba (Banvel)
		Fluroxpyr (Spotlight)
		Mecoprop, MCPP (Mecomec)
		Quinclorac (Drive) (broadleaves)
	Carotenoid biosynthesis (HPPD, hydroxyphenyl-pyruvate-dioxygenase) inhibition	Mesotrione (Tenacity)
		Topramezone (Pylex)
	Cellulose biosynthesis inhibition	Quinclorac (Drive) (grasses)
	Enolpyruvyl Shikimate-3 Phosphate (EPSP) synthase inhibition	Glyphosate (Roundup)
	Glutamine synthetase inhibition	Glufosinate (Finale)
	Photosystem I inhibition	Diquat (Reward)
	Photosystem II inhibition – Site A	Amicarbazone (Xonerate)
	Photosystem II inhibition – Site B	Bentazon (Basagran)
		Bromoxynil (Buctril)
	Photosystem II inhibition – different binding site	Siduron (Tupersan)
	PPO or Protox (protoporphyrinogen oxidase) inhibition	Carfentrazone (Quicksilver)
		Sulfentrazone (Dismiss)
	Unknown	MSMA, DSMA

PLANT GROWTH REGULATORS FOR FINE TURF
Bert McCarty

Plant growth retardants (PGR's) or inhibitors are increasingly being used to suppress seedheads and leaf growth due to rising mowing costs and danger posed to operators and other personnel. Traditionally, plant growth retardants have been used in the South to suppress bahiagrass (*Paspalum notatum* Flugge.) or tall fescue (*Festuca arundinacea*) seedhead production exclusively in low maintenance areas such as highway roadsides, airports, and golf course roughs. However, in recent years, new chemicals which may be used in higher maintained commercial turf situations have been developed.

Several undesirable characteristics which have been associated with growth retardants include: phytotoxicity (burn) of treated leaves from 4 to 6 weeks following applications; reduced recuperative potential from physical damage to treated turf; and increased weed pressure due to reduced competition from treated turf. Normally, growth retardants are used in low maintenance areas; therefore, these undesirable characteristics do not pose a problem to most managers. However, several growth regulatory materials have recently been developed for use on hybrid bermudagrass fairways and St. Augustinegrass. Vertical topgrowth (clippings) is suppressed, but horizontal spread (runners) is not. Therefore, turf recovery from golf club divots and other injuries occurs while topgrowth remains suppressed. Other uses involve areas where mowing has been discontinued due to heavy rains, equipment failure, etc., but topgrowth remains suppressed if the grass is treated. **Note: These retardants used on hybrid bermudagrass and St. Augustinegrass do not satisfactorily suppress seedhead development.**

PGRs are separated into two groups, Type I and Type II, based on their method of growth inhibition or suppression. Type I inhibitors are primarily absorbed through the foliage and inhibit cell division and differentiation in meristematic regions. They are inhibitors of vegetative growth and interfere with seedhead development. Their growth inhibition is rapid, occurring within 4 to 10 days, and lasts 3 to 4 weeks, depending on application rate. Mefluidide, chlorflurenol, and maleic hydrazide are examples of Type I inhibitors that inhibit mitosis in growth and development. Other Type I PGRs that inhibit plant growth and development through interruption of amino acid or organic acid biosynthesis are herbicides used at low rates. Being herbicides, their margin of safety is narrow and are very rate dependent. Examples of Type I herbicide regulators include glyphosate, imidazolinones, sulfonylureas, sethoxydim, and fluazifop.

Type II inhibitors are generally root absorbed and suppress growth through interference of gibberellic acid bio-synthesis, a hormone responsible for cell elongation. Type II PGRs are slower in growth suppression response, but their duration is usually from 4 to 7 weeks, again, depending on application rate. Type II PGRs have little effect on seedhead development and result in miniature plants. Paclobutrazol and flurprimidol are root absorbed Type II PGRS while trinexapac-ethyl is a foliar absorbed Type II PGR and is systemically translocated to the site of activity. Fenarimol is a type II fungicide that also suppresses annual bluegrass on putting greens.

Proxy 2L is a PGR with best activity on cool-season grasses. It promotes ethylene production in plants which is a regulatory hormone that restricts plant growth.
Root absorbed PGRs are activated by irrigation or rainfall after application and have less likelihood of over-lap leaf burn. Foliar absorbed materials (e.g., mefluidide, MH, and trinexapac-ethyl) require uniform and complete coverage for uniform response and must be leaf absorbed before irrigation or rainfall occurs. Usually low gallonage is used for foliar absorbed materials to minimize runoff from the leaf surface while high gallonage is used for root absorbed materials.

Timing of application for seedhead suppression is somewhat important. Applications made after seedhead emergence may not be effective. For bahiagrass, mow the area as seedheads initially emerge (usually in late May to early June) to knock down these and weeds present. Begin plant growth retardant treatment about two weeks following mowing or just prior to new seedhead appearance. Additional applications 6 to 8 weeks later may be required if new seedheads begin to emerge. A complete weed control program must accompany any plant growth retardant use. Typically, annual broadleaf weeds will become established in PGR use areas as the treated grass is not actively growing, therefore, is not providing its usual competition. Normally, 2,4-D and/or dicamba is included in this broadleaf weed control. Other postemergence herbicides such as Velpar, for grass weed control, may also be incorporated in low maintenance bahiagrass areas. The following tables list chemicals, application rates, and general remarks about each product used to suppress plant growth.

An available plant growth promoter is RyzUp from Abbott Laboratories. RyzUp is gibberellic acid which encourages cell division and elongation. When used, RyzUp helps initiate or maintain growth and prevent color changes (e.g., purpling) during periods of cold stress and light frosts on bermudagrass such as Tifdwarf and Tifgreen. Oftentimes, fall golf tournaments may experience an early light frost before the overseeding has become established. RyzUp helps the turf recover from this discoloration. PGRIV from MicroFlo is a combination of gibberellic acid and indolebutyric acid that is foliar absorbed. Research suggests this combination promotes root growth and vigor of certain plants growing under stressful conditions. Gibberellic acid containing PGRs also are used to “reverse” the inhibitory effects of Type II PGRs.

Characteristics of Plant Growth Regulators used in Fine Turf.

Active ingredient (trade name example)	Turfgrass Uses												Site of Uptake		Specific Uses			Mode of Action
	Bahiagrass	Bermudagrass	Centipedegrass	Creeping bentgrass	Fine fescues	Ky. bluegrass	Kikuyugrass	Perennial ryegrass	*Poa annua*	St. Augustinegrass	Tall fescue	Zoysiagrass	Root	Foliar	Overseeding Aid	Golf Greens	Seedhead suppression	
Ethephon (Proxy)	—	—	—	**Y**	**Y**	**Y**	—	**Y**	—	—	**Y**		—	**Y**	—	—	—	Promotes ethylene which reduces cell elongation
Flurprimidol (Cutless)	—	**Y**	—	**Y**	—	**Y**	—	**Y**	—	**Y**	—	**Y**	**Y**	—	—	**Y**	—	Type II GA inhibitor of cell elongation
Gibberellic acid (RyzUp)	—	**Y**	—	—	—	—	—	—	—	—	—	—	—	**Y**	—	—	—	Chlorophyll (color) retention
Indolebutyric acid + gibberellic acid	—	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	—	**Y**	**Y**	**Y**	—	**Y**	—	**Y**	—	Enhance root growth & plant vigor
Maleic hydrazide (Slo Gro)	**Y**	**Y**	—	—	**Y**	**Y**	—	**Y**	—	—	**Y**	—	—	**Y**	**Y**	—	**Y**	Type I growth & seedhead inhibitor
Mefluidide (Embark 2S)	—	**Y**	**Y**	*	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	—	**Y**	**Y**	—	**Y**	Type I growth & seedhead inhibitor
Paclobutrazol (Trimmit/TGR)	—	**Y**	—	**Y**	**Y**	**Y**	—	**Y**	—	**Y**	**Y**	—	**Y**	—	**Y**	**Y**	—	Type II GA inhibitor of cell elongation
Trinexapac-ethyl (Primo)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	—	**Y**	**Y**	**Y**	—	Type II GA inhibitor of cell elongation
Amidochlor (Limit)	—	—	—	—	—	**Y**	—	**Y**	—	—	**Y**	—	**Y**	—	—	—	**Y**	Type I cell division inhibitor

Y = Yes.

* Embark T&O 0.2S can be used to control *Poa annua* seedheads in creeping bentgrass fairways.

Chemicals for Seedhead and Plant Growth Suppression (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Turf Use	Chemical Name (rate, lbs ai/acre)	Trade Names (rate, product)	Remarks
Bentgrass, Kentucky Bluegrass, Perennial Ryegrass, Tall and Fine Fescue Fairways, Roughs, and Commercial Areas	ethephon (3.4)	Proxy 2L (1.7 gal/acre or 5 fl oz/1000 ft^2)	Apply only to actively growing turfgrass not suffering heat, moisture, disease, or insect stress. Seven to 10 days are necessary for activity. Repeat applications can be made 4 weeks following the first for bentgrass and fescues & 7 weeks for Kentucky bluegrass & perennial ryegrass. A spreader/sticker is not needed.
	amidochlor (2.5)	Limit 4F (0.625 gal/acre)	Root absorbed. Use on nonresidential medium to low-managed turf such as cemeteries, parks, industrial and office sites and low maintenance areas (e.g., roughs, out-of-play areas) on golf courses. Water in within 5 days of application & before mowing. May cause some yellowing. Not recommended for areas of play. Also control some broadleaf weeds.
	paclobutrazol + flurprimidol + trinexapac-ethyl (0.14 to 0.28 lb)	Musketeer 1L (18 to 36 oz/a)	For turf growth suppression, make the initial spring application at 18 to 30 oz/a with repeat applications 2 to 6 weeks later at 18 to 36 oz/a.
Turfgrass Clipping Management/Turfgrass Enhancement	mefluidide (0.125 to 1.0)	Embark 2S (½ to 4 pts/15-150 gal water) Embark T&O 0.2S [5 pts (St. Augustinegrass)]	Foliar absorbed. Apply to common bermudagrass (4 pts/A Embark 2S), tall fescue & Ky. bluegrass (1½ pts/A Embark 2S), and St. Augustinegrass (Embark Lite) only. Apply in spring approximately 2 weeks before seedhead appearance. Do not apply to turf within 4 growing months after seeding. Do not water-in and do not reseed within 3 days after application. Treated turf may appear less dense and temporarily discolored. Adding 1 to 2 qts of a nonionic surfactant per 100 gal of spray solution may enhance suppression; however, discoloration may also be increased. *Poa annua* seedhead control in fairways is with ½ pt/A in early January. Iron applications may lessen discoloration. Read and follow label recommendations before use. Miscellaneous family.
	flurprimidol (0.375 to 1½)	Cutless 50 WP (¾ to 3½ lb to 200 gal water or 0.28 to 1.3 oz/1,000 ft^2) Cutless MEC (6 to 74 fl oz/A)	Root absorbed. Apply to bermudagrass or zoysiagrass golf course fairways, hard-to-mow and trim areas. Provides 4 to 8 week suppression. Must be uniformly applied and irrigated-in with ½ inch water. Flurprimidol does not completely control seedheads. Temporary turf discoloration may follow this treatment. St. Augustinegrass, bahiagrass, and common bermudagrass require the higher rate. Repeat applications every 4 weeks on Tifway bermudagrass with 1.0 lb/A will minimize turf injury. Do not use with SI/DMI fungicides.
	flurprimidol + paclobutrazol + trinexapac-ethyl (0.093 to 0.23)	Musketeer 0.99L (12 to 30 fl oz/A)	Used to suppress annual bluegrass or to manage growth and clippings in bermudagrass, creeping bentgrass, Ky. bluegrass, and perennial ryegrass. Apply 12 to 18 fl oz/A on bentgrass putting greens and up to 30 fl oz/A on other turf species. Spray interval from 2 to 6 weeks depending on desirable growth suppression and rate used.
	trinexapac-ethyl (0.02 to 0.086)	Primo MAXX 1L (3 to 11 oz in 20 to 100 gal water)	Foliar absorbed. Use 3 oz/a for Tifdwarf bermudagrass greens and 6 oz/a for Tifgreen bermudagrass greens. Tifway & common bermudagrass fairways require 11 oz/a. Bermudagrass overseeding preparation requires 22 oz/a 1 to 5 days before overseeding and before verticutting, scalping, or spiking. One hour rain-free period is needed after application. Mowing 1 week after application improves results & appearance as will repeat applications in 3 to 4 weeks. Temporary turf discoloration may follow treatment. Do not add a surfactant. A 25 WSP formulation is also available. Cyclohexadione family.

Chemicals for Seedhead and Plant Growth Suppression (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Turf Use	Chemical Name (rate, lbs ai/acre)	Trade Names (rate, product)	Remarks
	paclobutrazol (½ to 1)	TGR Turf Enhancer 50WP (1 to 1½ lb/43 to 100 gal) Trimmit 2SC (1 to 2 gal)	Root absorbed. Apply to well-maintained St. Augustinegrass or hybrid bermudagrass fairways. Used on overseeded golf greens during winter for turf enhancement and for annual bluegrass suppression. Do not apply to saturated soils and treat only dry foliage. Repeat applications 8 weeks apart may be made. Read & follow directions before use.
	flurprimidol + trinexapac-ethyl	Legacy 1.52MEC (5 to 30 oz/A) Edgeless 1.51 L (3o to 60 gl oz/A)	A pre-tank combination of flurprimidol + trinexapac-ethyl to provide darker green turf color, improved turf quality, longer growth suppression than either product alone, *Poa annua* suppression, extended growth suppression, and less scalping/rebound effect. Used on bentgrass, Ky. bluegrass, P. ryegrass, bermudagrass, and seashore paspalum fairways and sports fields.
Foliar Suppression of Overseeded Bermudagrass	mefluidide (0.125)	Embark 2S (½ pts/15-150 gal water)	Foliar absorbed. Do not apply to turf within 4 growing months after seeding, and do not reseed within 3 days after application. Treated turf may appear less dense and temporarily discolored. Adding 1 to 2 qts of a nonionic surfactant per 100 gal of spray solution may enhance suppression; however, discoloration may also be increased. *Poa annua* seedhead control in fairways is with ½ pt/A in early January. Iron applications may lessen discoloration. Read and follow label recommendations before use.
	flurprimidol (0.375 to 1½ lb)	Cutless 50W (¾ to 3 lb/50 to 200 gal water)	Root absorbed. Apply to zoysiagrass or bermudagrass in late spring-early summer and/or late summer-early fall. Time the second application at least 3 months before expected dormancy. Do not apply to putting greens. Do not exceed 1½ lb/A per application on sandy soils. Irrigate with ½ in. water & resume mowing 3 to 5 days after application. Do not use with SI/DMI fungicides.
	paclobutrazol (¼ lb)	Turf Enhancer 50 WP (½ lb/40 to 100 gal water)	Root absorbed. Repeat applications may be made 3 weeks apart. Do not use if *Poa annua* exceeds 70%. Application should be in early January.
	fluyrprimidol + trinexapac-ethyl paclobutrazol + flurprimidol + trinexapac-ethyl (0.156 to 0.31 lb)	Legacy 1.51L (5 to 10 fl oz/A) Musketeer 1L (20 to 40 oz/a)	For *Poa annua* and turf growth suppression in overseeded ryegrass (except bermudagrass putting greens). Apply in early spring and late fall to suppress annual bluegrass or to suppress turf growth and to manage clippings. Treatment intervals every 2 to 6 weeks. Use lower rates on putting greens with >50$ annual bluegrass populations. Delay applications on overseeded fairways until 4 weeks after germination.

Chemicals for Seedhead and Plant Growth Suppression (*Refer to Herbicide Label for Specific Turf Species Use Listing*)

Turf Use	Chemical Name (rate, lbs ai/acre)	Trade Names (rate, product)	Remarks
Poa annua var. *reptans* (perennial biotype) Conversion/Management in Bentgrass Golf Greens	paclobutrazol (0.375)	Turf Enhancer 50 WP (0.75 lb/acre or 0.28 oz/1000ft^2) Trimmit/Turf Enhancer 2 SC (24 oz/acre or 0.55 fl.oz./1000ft$^{2)}$	Root absorbed. Apply 30 days apart 2 to 3 times in mid-fall (September to early Dec.) plus 2 to 3 times in very early spring (late Feb. to early May) when bentgrass is actively growing. Increased Poa control often occurs if a sterol inhibitor fungicide (DMI) such as Banner Maxx at 1 oz/1000 sq.ft. is applied 2 weeks following each paclobutrazol applications. Do not use if *Poa annua* populations exceed 70% as severe stand thinning or discoloration may result. **Note:** This program is designed as a gradual transition or conversion from *Poa annua* to bentgrass. Repeat applications over several years will be required. Treated Poa will appear noticeably lighter green in color while treated bentgrass may appear 'grainy.' It is highly recommended to start at lower rates (e.g, 8 to 12 oz/a) to ensure proper coverage and application calibration before using more aggressive rates.
	ethephon (3.4 lbs)	Proxy 2SL, Ethephon 2SL (1.7 gal/A)	Make initial application before seedheads emerge. Repeat applications are needed every 10 to 21 days during seedhead emergence. Often mixed with trinexapac-ehtyl PGR for improved turfgrass quality.
	flurprimidol (0.125 to ½)	Cutless 50W (¼ to ½ lbs/acre) Cutless MEC 1.3L (6 to 24 fl oz/A)	Apply in spring or in the fall. Repeat at 3 to 4 week intervals with the final application 8 weeks before winter dormancy or summer stress. Delay reseeding for 2 weeks after application.
	paclobutrazol + flurprimidol + trinexapac-ethyl (0.10 to 0.17 lb)	Musketeer 1L (12 to 22 oz/a)	For *Poa annua* and turf growth suppression. Use lower rates if the % Poa annua population is >50%. Treatment interval are 2 to 4 weeks apart.
Extending the Life of Painted Lines on Sports Fields	trinexapac-ethyl	Primo MAXX 1EC (1 oz/gallon paint) Primo 25 WSB (½ oz/gallon paint)	Used to extend the life of painted lines which reduces labor costs. The life expectancy of painted lines is extended 7 to 14 days on cool-season grasses and up to 30 days on warm-season grasses. One gallon of paint should treat approximately 1000 sq.ft. of line surface area.
Chemicals for Growth & Color Promotion of Bermudagrass such as Tifdwarf & Tifgreen	Gibberellic Acid (10 grams ai/A)	RyzUp/ProGibb 4% active solution (10 fl oz/A or 0.23 fl oz/1000 sq.ft.)	Apply 10 grams ai/acre weekly or 25 grams ai/acre biweekly in 25 to 100 GPA to promote the growth and prevent discoloration (e.g., purpling) during periods of cold stress and light frosts on bermudagrass such as Tifdwarf or Tifgreen. Do not apply when night temperatures exceed 65F. A combination product of indolebutryric acid + gibberellic acid is available as PGR IV.

Read and follow all label recommendations. Products listed are for use by professional turf managers only. Trade and brand names are used for information only. The South Carolina Cooperative Extension Service does not guarantee nor warrant the standard of any product mentioned; neither do they imply approval of any product to the exclusion of others which may also be suitable. The following conversions may be useful. Gal/acre x 2.938 = oz/1,000 ft^2; Qt/acre x 0.7346 = oz/1,000 ft^2; Pint/acre x 0.3673 = oz/1,000 ft^2; lbs/acre x 0.02296 = lb/1,000 ft^2.

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Amicarbazone	-Xonerate 70WDG
Aminoclopyrachlor	-Imprelis 80DF, 2SL
Aminoclopyrachlor + chlorosulfuron	-Perspective
Aminoclopyrachlor + chlorsulfuron + sulfometuron	-Plainview
Aminoclopyrachlor + metsulfuron	-Streamline
Aminoclopyrachlor + metsulfuron + imazapyr	-Viewpoint
Aminopyralid	-Milestone 2L
Aminopyralid + 2,4-D	-ForeFront 3.74L
Aminopyralid + metsufluron	-Opensight
Aminopyralid + triclopyr amine	-Milestone VM 2L
Ammoniated soap of fatty acids	-Quick-fire, Herbicidal Soap
Asulam	-Asulox 3.34L, Asulam 3.3L
Atrazine	-AAtrex, Atrazine Plus, Purge II, Aatrex 90, Atrazine 4L, Bonus S, St. Augustine Weedgrass Control + others
Benefin	-Balan 2.5G. 1.5EC, Crabgrass Preventer, + others
Benefin + oryzalin	-Surflan XL 2G, XL 2G
Benefin + oxadiazon	-Regalstar 1.5G
Benefin + trifluralin	-Team 2G, Crabgrass Preventer 0.92%, Team Pro
Bensulide	-Betasan, Pre-San 12.5 & 7 G, Bensumec 4L, Lescosan, Weedgrass Preventer, Betamec, Squelch, + others
Bensulide + oxadiazon	-Goosegrass/Crabgrass Control 6.56G
Bentazon	-Basagran T/O 4L, Lescogran 4L, Nutgrass ‘Nihilator
Bentazon + atrazine	-Prompt 5L, Laddock S-12
Bispyribac-sodium	-Velocity 80WP, 17.6 WDG, 0.176SC, Regiment 80WP
Bromoxynil	-Broclean, Buctril 2L, Brominal 4L, Bromox 2E, Moxy 2E
Cacodylic Acid	-Montar, Weed Ender
Carfentrazone	-Quicksilver T&O 1.9 L, Aim, Shark
Carfentrazone + 2,4-D + dicamba + MCPP	-Speed Zone Southern, Speed Zone Northern and Bermuda 2.2L
Carfentrazone + dicamba + MCPA + MCPP	-Power Zone,
Carfentrazone + quinclorac	-Square One 70WDG
Carfentrazone + sulfentrazone	-Spartan Charge 4F
Chlorsulfuron	-Chlorsulfuron 75DF, Corsair 75DF, Telar 75DG
Clethodim	-Envoy 0.94 EC, Clethodim 2EC

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Clopyralid	-Lontrel T&O 3L, Transline 3L, Stinger 3L
Clopyralid + dichlorprop + MCPA	-Chaser Ultra
Clopyralid + MCPA + triclopyr	-Battleship
Clopyralid + triclopyr	-Confront 3L, Confront NR, Redeem R&P, 2D 3L
CMA (CAMA)	-Calar 1L, Ortho Crabgrass Killer - Formula II, Selectrol
Corn gluten	-Dynaweed, WeedzSTOP 100G
Cytokinin	-Agriplex PGR for T&O
2,4-D	-2,4-D Amine 4 & Ester, Barrage HF, Clean Amine, Saber, Weedone LV4, Dacamine, Weedar 64, AM-40, 2,4-D LV4, Dymec, Lesco A-4D, Hardball, Esteron 638, Savana, + others
2,4-D + clopyralid + dicamba	-Millennium Ultra 3.75 L
2,4-D + clopyralid + triclopyr	-Momentum, Confront 3
2,4-D + dicamba	-81 Selective Weedkiller, Four Power Plus, Triple D Lawn Weed Killer, Banvel 2,4-D
2,4-D + dicamba + MCPP + MCPA and/or 2,4-DP	-Trimec Southern, Three-Way Selective, Eliminate DG, 3D, 33-Plus, Dissolve, EndRun, Triamine 3.9 lb/gal, TriEster, Triplet, Trex-San, Weed-B-Gon, 2 Plus 2, Bentgrass Selective Weed Killer, Threesome, Trimec Bentgrass Formula, TruPower 2, Strike 3, Broadleaf Trimec, MECAmine-D, Trimec 899, 992, & 1000, Vessel, Weed-B-Gon for Southern Lawns, Formula II, Endrun 3.22L + others
2,4-D + dicamba + MCPP + MSMA	-Trimec Plus 2.64L, Quadmec 2.64L
2,4-D + dicamba + MCPP + pyraflufen	-4-Speed 3.1L, RedZone 2
2,4-D + dicamba + MCPP + sulfentrazone	-Surge 2.18L, SureZone
2,4-D + dicamba + quinclorac	-Quincept 1.875L, Momentum Q, 2DQ
2,4-D + dicamba + sulfentrazone + quinclorac	-Q4 Plus 1.8L
2,4-D + dicamba + sulfentrazone + triclopyr	-T-Zone Broadleaf Herbicide 2.51L
2,4-D + dicamba + triclopyr + pyraflufen	-4-Speed XT 2.9L
2,4-D + dichlorprop (2,4-DP)	-2D + 2DP Amine, Turf D + DP, Fluid Broadleaf Weed Control, Turf Weed & Brushy Control, Weedone DPC Ester & Amine + others
2,4-D + dichlorprop (2,4-DP) + dicamba	-Super Trimec, Brushmaster
2,4-D + dichlorprop (2,4-DP) + MCPP	-Broadleaf Granular Herbicide, Dissolve, Spoiler 4.1L,Triamine, Triamine Jet-Spray Triplet SF, Turf Weeder, Weed Whacker
2,4-D + DSMA	-Weed Beater Plus
2,4-D + fluroxypyr + dicamba	-Escalade 4.4L, Escalade2 4L
2,4-D + fluroxpyr + dichlorprop (2,4-DP)	-Strike Three Ultra 2
2,4-D + glyphosate	-Campaign 3.1 L, LandmasterII 2.2L
2,4-D + mecoprop (MCPP)	-2D Amine + 2MCPP, 2 Plus 2, MCPP-2,4-D, Phenomec, Ortho Weed-B-Gon Lawn Weed Killer, + others

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
2,4-D + MCPP + 2,4-DP	-Broadleaf Granular Herbicide, Dissolve, Spoiler, Triamine, Tri-Ester, 3-Way Weed Control, Turf Weeder + others
2,4-D + picloram	-Pathway
2,4-D + triclopyr + fluroxypyr	-Momentum FX2
2,4-D TIPA + fluroxypyr + dicamba	-Escalade Low Odor 4.4L
2,4-D TIPA + MCPP + dicamba	-Triplet Low Odor
2,4-D + triclopyr	-Aquasweep, Turflon II Amine, Chaser 3L Ester, Chaser 2 Amine, Crossbow 3L Ester
Dazomet	-Basamid G
2,4-DP + MCPA + MCPP	-Triamine II, Tri-Ester II
DCPA	-Dacthal W-75 WP, Dacthal 6F
Dicamba	-Diablo, Vanquish 4 L, K-O-G Weed Control, Bentgrass Selective, Banvel 4S, Oracle, Vision, Clarity, + others
Dicamba + diflufenzopyr	-Overdrive 70WG
Dicamba + iodosufluron + thiencarbazone	-Celsius 68WDG
Dicamba + MCPA + MCPP	-Encore DSC, Tri-Power Dry, Tri-Power Selective, Trimec Encore DSC
Dicamba + MCPA + triclopyr	-Eliminate, Three-Way Ester II, Horsepower 4.56 lb/gal, CoolPower 3.6 lb/gal, Clover Power, Spurge Power
Dicamba + MCPP + triclopyr	-3-Way Ester II
Dicamba + MCPP + quinclorac	-OneTime 2.45L
Dichlobenil	-Casoron 4G, Barrier 4G
Diclofop	-Illoxan 3EC
Dikegulac-sodium	-Atrimmec1.67L, Augeo 1.67L
Dimethenamid	-Tower 6L, Outlook 6L
Dimethenamid + pendimethalin	-FreeHand 1.75G
Diquat	-Diquat SPC 2L, Redwing, Reward 2LS, Solera Diquat, Tsunami DQ, WeedPlex Pro, Watrol, Vegetrol, Aquatate, Aquatrim II
Diquat + glyphosate	-QuikPRO, Prosecutor Swift Acting, Rozor Burn 3.1L
Dithiopyr	-CGC 40, Dimension 1L, Dimension Ultra 40WSP, Dithiopyr 40WSB. Lifeguard, Crab and Spurge Preventer, Dimension 270-G
Dithiopyr + oxadiazon	-SuperStar
Diuron	-Karmex, Diuron
Diuron + imazapyr	-Sahara DG
DSMA	-Ansar, DSMA Liquid, Methar 30, Namate, DSMA 4
Ethofumesate	-Prograss 1.5EC, 4.0SC

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Ethephon	-Proxy 2L, Ethephon 2, ProTrim
Fenarimol	-Rubigan 1AS, Patchwork 0.78G
Fenoxaprop	-Acclaim Extra 0.94L, 0.57L, Whip 360
Flazasulfuron	-Katana 25WG
Florasulam	-Defendor 0.417SC
Fluazifop	-Fusilade II T&O, Ornamec 170, Ornamec Over-The-Top
Flucarbazone	-Align 70WDG, Everest
Flumioxazin	-SureGuard 51WDG, BroadStar 0.25G, Payload 51WDG
Fluroxypyr	-Spotlight 1.5L, Vista 1.5L, Vista XRT 2.8L
Fluroxypyr + MCPA + triclopyr	-Battleship III
Fluroxypyr + MCPP	-Bastion T
Fluroxypyr + triclopyr	-PastureGard HL, Tailspin 1.33L
Flurprimidol	-Cutless 50WP, Cutless MEC 1.3L
Flurprimidol + trinexapac-ethyl	-Edgeless 1.51L, Legacy 1.52 MEC
Flurprimidol + paclobutrazol + trinexapac-ethyl	-Musketeer 1L
Foramsulfuron	-Revolver 0.19L
Foramsulfuron + halosulfuron + thiencarbazone-methyl	-Tribute Total 60.5WDG
Fosamine	-Krenite 4S
Gibberellic Acid	-RyzUp, ProGibb T&O
Gibberellic Acid + indolebutyric acid	-PGR IV
Glufosinate	-Finale 1L, Liberty, Ignite
Glyphosate	-Departure, Roundup Pro 4L, Roundup ProDry, Accord 4L, Gly-Flo, Clear-Out 41 Plus, Glypro, Glyfos, AquaNeat, Razor Pro, Rodeo 5.4L, Kleenup Pro, Pronto, Refuge, Showdown, Weed Wrangler, Prosecutor, Touchdown Pro, Trailblazer, Glyphomate 41 (3.8L), Fireball 1.55L (acid) + others
Glyphosate + imazapic	-Journey 2.25L
Glyphosate + imazapyr	-Pronto Vegetation Killer 0.36L
Glyphosate + prodiamine	-ProDeuce 4.75L
Halosulfuron	-Sedgehammer 75WP, Sandea 75WP, Manage 75WP, Sempra 75WP, Prosedge 75WP, Permit 75WP
Halosulfuron + dicamba	-Yukon
Hexazinone	-Velpar 2L
Imazamox	-Raptor 1L

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Imazapic	-Plateau 70DG, Panoramic 2SL, Impose 2L
Imazapyr	-Arsenal 2S, Arsenal Powerline 2L, Arsenal Applicators Concentrate 4L, Habitat, Chopper, Stalker
Imazaquin	-Image 1.5L, 70DF
Imazethapyr + sulfentrazone	-Dismiss South 4SC
Imazosulfuron	-Celero 75WDG
Indaziflam	-Specticle 20WP, Specticle Flo 0.622L
Isoxaben	-Gallery 75DF, Isoxaben 75WG
Isoxaben + oxyfluorfen + trifluralin	-Showcase 2.5G
Isoxaben + trifluralin	-Preen 1.9G, Snapshot 2.5 TG, Gallery + Team Woodace Preen Plus
Maleic hydrazide	-Royal Slo-Gro
MCPA	-Weedar MCPA 4 lb/gal, MCPA-4 Amine, MCPA Ester 4 + others
MCPP (mecoprop)	-Mecomec 4, Chickweed & Clover Control, Lescopex, MCPP-4 Amine, MCPP-4K + others
MSMA	-Daconate 6, Dal-E-Rad, Crab-E-Rad, MSMA 6.6L, Drexar 530, Bueno 6L, 120 Herbicide, Daconate Super, 912 Herbicide, MSMA Turf, Summer Crabicide, Target MSMA, Weed Hoe, + others
Mefluidide	-Embark T&O, Embark 2S, Sta-Lo
Mesotrione	-Tenacity 4L
Methiozolin	-PoaCure 25L
Methyl chlorflurenol	-Maintain CF
Metribuzin	-Sencor 75DF
Metolachlor	-Pennant 7.8 lb/gal, Pennant Magnum 7.62L
Metsulfuron	-Manor 60 DF, Blade 60DF, Escort 60 DF, Patriot 60 WDG, Metsulfuron Pro, MSM Metsulfuron 60DF, MSM Turf, Mansion
Metsulfuron + nicosulfuron	-Pastora 71DF
Metsulfuron + rimsulfuron	-Negate 37WG
Metsulfuron + sulfentrazone	-Blindside 66WG
Methyl Bromide	-Brom-O-Gas, Terr-O-Gas, MB 98, MBC
Napropamide	-Devrinol 50 DF, 2G, 10G, Ornamental Herbicide 5G
Napropamide + oxadiazon	-PrePair 6G
Norflurazon	-Predict
Oryzalin	-Surflan AS 4 lb/gal, Oryzalin Pro, Weed Impede, Surflan Coated Granules, Proazlin 4L
Oxadiazon	-Ronstar 2G, 50WP, Ronstar Flo 3.17 L, Oxadiazon 50 WSP, 2G, & SC
Oxyfluorfen	-Goal 2XL

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Oxyfluorfen + oryzalin	-Rout
Oxyfluorfen + oxadiazon	-OO-Herbicide 3G, Regal OO, LaSar
Oxyfluorfen + pendimethalin	-OH2
Paclobutrazol	-Cutdown, Turf Enhancer 50WP, 2SC, Trimmit 2SC, TGR, Armor Tech PAC 223, Tide Paclo 25C
Paraquat	-Gramoxone Max 3L
Pelargonic Acid	-Scythe, Quik
Pendimethalin	-Pendulum (3.3EC, 2G), Pendulum AquaCap (3.8 CS), Hurdle, Turf Weedgrass Control, Halts, Corral 2.68G, ProPendi, Pendiflex 32, Pentagon, PRE-M, Pin-Dee 3.3 T&O
Pendimethalin + oxadiazon	-Kansel + (20-2-13) 3G
Penoxsulam	-LockUp G, Sapphire, Grasp, Granite
Picloram	-Grazon, Tordon K
Prodiamine	-Barricade 65WDG, Endurance 65 WDG, eVade 4L, Factor 65 WDG, Guardrail 65WDG, Kade 65WDG, RegalKade 0.5G & 0.37G, Prodiamine 4L & 65 WDG, Stonewall, ProClipse 65WDG, Cavalcade + others
Prodimaine + quinclorac	-Cavalcade PQ
Prodiamine + oxadiazon	-Regalstar II 1.2G
Prodiamine + sulfentrazone	-Echelon 0.3G, 4SC
Pronamide	-Kerb 50WP
Pyraflufen-ethyl	-Octane 2%SC (0.177 lbs/gal)
Pyraflufen-ethyl + metsulfuron	-Caliente
Quinclorac	-Drive 75DF, XLR8 (1.5L), Facet, Paramount, Quinclorac 75DF, 1.5L, Eject 75DF, QuinPro Herbicide
Quinclorac + sulfentrazone	-Solitaire 75WG
Rimsulfuron	-Rimsulfuron 25DF, TranXit GTA 25DG Matrix, Titus
Sethoxydim	-Segment 1L, Sethoxydim G-Pro 1L, Vantage 1.0 lb/gal, Grass Getter, Poast, Poast Plus
Siduron	-Tupersan 50WP, 3.5%G, 4.6%G, 470, Crabgrass Control
Simazine	-Princep 4 lb/gal, T&O, 80WP, Simazine 4L & 90DF, Wynstar, Sim-Trol 90DF, + others
Sulfentrazone	-Dismiss Turf Herbicide 4L, Spartan 4F, Authority
Sulfometuron-methyl	-Oust 75DG, Spyder 75DG, SFM G-Pro 75EG
Sulfosulfuron	-Certainty 75WDG, Outrider 75WDG, Monitor, Maverick
Topramezone	-Pylex 2.8SC, Impact
Triclopyr	-Turflon Ester 4L, Garlon 3A (amine), 4A (ester), & Ultra 4L (ester), Pathfinder 1L (RTU), Tahoe 3A & 4E, Grandstand, Remedy Ultra, Triclopyr 4
Trifloxysulfuron	-Monument 75WG, Envoke

Herbicide and PGR Common and Trade Names*
Bert McCarty

Common Name	Trade Name(s)
Trifluralin	-Treflan 5G, Trifluralin 4EC, Trilin 4EC, 5EC, Preen, Vegetable and Ornamental Weeder
Trinexapac-ethyl	-Primo 1EC, Triple Play, Primo WSP, Primo MAXX, Governor 0.055% 5-0-10; 0.17%, Palisade, Groom PGR, PGR 113, Podium, RegiMax PGR, T-NEX, T-Pac Epro, Trinexapac-ethyl 1AQ
Xanthomonas campentris	-X-Po

*Refer to the herbicide label for specific site and use registration.

All chemicals mentioned are for reference only. Not all are available for turf use. Some may be restricted by some states, provinces, or federal agencies. It is advisable to check the current status of the pesticide being considered for it use. Always read and follow the manufacturer's label as registered under the Federal Insecticide, Fungicide, and Rodenticide Act. Mention of a proprietary product does not constitute a guaranty or warranty of the product by the authors or the publishers of this book and does not imply approval to the exclusion of other products that also may be suitable.

ACTIVATED CHARCOAL FOR PESTICIDE DEACTIVATION

Bert McCarty

Activated charcoal (also called activated carbon) is often used to adsorb or deactivate organic chemicals such as pesticides. Activated charcoal has been used for many years to remove organic contaminants from waste waters and in water purification systems. Since most pesticides are organic chemicals, activated charcoal can effectively be used to deactivate or "tie up" these products in soil. Once the pesticide has been adsorbed onto activated charcoal, it is biologically inactive and cannot cause injury to the turfgrass. Therefore, this product can be beneficial to turfgrass managers in the case of an accidental pesticide spill or where a herbicide needs to be inactivated for seeding or sprigging of turfgrasses. Due to its dark color, thus ability to absorb heat, activated charcoal is also used to artificially warm the soil to minimize the effects of light frosts or to allow earlier seeding of an area.

Charcoal is porous, soft, black substance made by heating in an restricted amount of air, substances containing carbon such as material from hardwood trees and coconut shells. Powdered activated charcoal is made up of very small carbon particles that have a high affinity for organic chemicals such as pesticides. Activated charcoal has a large surface area and can absorb 100 to 200 times its own weight.

The amount of activated charcoal to apply to a pesticide-contaminated area varies with the chemical characteristics of the particular pesticide. Rates generally range from about 100 to 400 pounds of activated charcoal per acre (2.3 to 9.2 pounds per thousand square feet) for each pound of active ingredient of a pesticide applied per acre. A general rule is to apply about 200 pounds of activated charcoal per acre (4.6 pounds per thousand square feet) for each pound of pesticide active ingredient per acre.

Rates of activated charcoal used for spills and deactivating turf pesticides.

Application	Recommendation	Comments
Spills	For reducing the effects from spills of organic pesticides, some petroleum products, and hydraulic fluids.	Use 100 to 400 lbs of activated charcoal to every pound of active material spilled per acre (2.3 to 9.2 lbs/1000 ft^2). If the active material has not been diluted with water at the time of spill, apply the charcoal directly as a dry power. If the active material has been diluted with water, apply the activated charcoal in a slurry with a sprinkle can or common sprayer equipment. The charcoal must be incorporated into the contaminated soil, preferably to a depth of 6 inches. With severe spills, some of the contaminated soils may need removal prior to activated charcoal application.
'Deactivating' turf herbicides and soil warming	Turf areas that have been treated with preemergence herbicides can be reseeded earlier than normal by treating with activated charcoal.	Whenever it is desirable to terminate a preemergence herbicide, apply charcoal slurry at a rate of 2 to 4 lbs/1000 sq.ft. Water the slurry into the soil. Make sure the grass is washed free of heavy charcoal deposits. Where possible, it is desirable to rake the charcoal into the soil thoroughly. The area can be seeded 24 hrs after treatment.

Example: Suppose Balan 2.5G was inadvertently applied at 2 pounds of active ingredient per acre to an area to be seeded with a turfgrass. To completely inactive this herbicide, an application of activated charcoal at 400 pounds per acre (or 9.2 pounds per 1000 square feet) would be needed. See the following table for additional conversions of rates per acre to pounds per 1000 square feet.

Conversion from Pounds of Activated Charcoal Per Acre to Pounds of Activated Charcoal Per 1000 Square Feet.

Rate of Activated Charcoal (pounds per acre)	Activated Charcoal Needed (pounds per 1000 square feet)
100	2.3
200	4.6
400	9.2
800	18.4
1,600	36.7
3,200	73.5

Activated charcoal can be applied by various methods. It can be applied in the dry form with a drop spreader. However, activated charcoal particles are easily moved by wind, so it may be difficult to distribute the charcoal evenly when applied in the dry form. The easiest method is to suspend the charcoal in water and apply it by hand with a watering can (for small areas) or a power sprayer. Because activated charcoal does not mix easily with water, a 0.5 % solution of a nonionic surfactant (equivalent to 1 quart per 50 gallons) will enhance its suspension in water.

Note that charcoal particles are very abrasive and can damage spray equipment (particularly rotary type pumps). Therefore, if a sprayer is used to apply activated charcoal, care should be taken to thoroughly clean the equipment when finished.

When deactivating a pesticide in a seedbed, the activated charcoal should be incorporated with a rotary tiller or other appropriate equipment so that the charcoal is placed in the upper few inches of soil. The objective is to get the activated charcoal in the same proximity as the pesticide. Uniform application of activated charcoal followed by thorough mixing is the key to inactivating a pesticide-contaminated area. If the pesticide is on the turf, in the thatch layer, or uppermost surface of the soil (for instance, if the pesticide has not been watered in), the pesticide can be inactivated by simply applying the charcoal to the area and thoroughly watering once charcoal application is complete. Again, the objective is to place the charcoal in the same proximity as the pesticide. If activated carbon is applied and either incorporated or watered correctly, inactivation of the pesticide will be successfully accomplished. For application convenience, it is recommended that activated charcoal be applied as a water slurry. To minimize dusting, always add activated charcoal to water slowly, keeping the bag as close to the water surface as possible. The following steps are suggested when mixing and applying charcoal.

Spray Application

1. Make sure spray equipment, tubing, and nozzles are completely clean. Screens should be removed if practical.
2. The final spray mixture should contain 1 to 2 lbs of charcoal per gallon of water.
3. Add sufficient water to begin moderate agitation. Simultaneously add the balance of required water and charcoal. Continue agitation until a uniform mixture is obtained.
4. Maintain moderate agitation while spraying.

It is important to understand situations where activated charcoal will not work. If a herbicide has been applied for several weeks and rainfall has occurred and/or irrigation water has been applied, the herbicide is most likely past the thatch layer and, depending on water solubility and soil adsorption of the herbicide, is probably in the upper inch or so in the soil. In this case, activated charcoal would have to be physically incorporated with a rotary tiller or other implement to get the charcoal in contact with the herbicide. The reason is activated charcoal will not leach through soil. If activated charcoal is applied to the soil surface and watered, the charcoal will remain on top of the soil and will not inactivate the herbicide below the soil surface. Activated charcoal is considered ineffective for inorganic pesticides such as arsenates, lead compounds, sodium chlorate, sulfur, borax, etc., and water-soluble organic pesticides such as, but not limited to, MSMA, and DSMA.

Activated carbon is available from most suppliers of turfgrass products. It is a good idea to keep several bags on hand so it can be applied immediately instead of having to wait for delivery. Several different brands and formulations are on the market. There appears to be little if any differences in effectiveness of the different brands. However, some may be easier to apply than others, depending on the particular situation where it is to be used.

Suppliers of activated charcoal include:

'Gro-Safe' from: American Norit Co., Inc. 1050 Crown Pointe Parkway Atlanta, GA 30338 1-800-641-9245	'Clean Carbon' from: Aquatrols 5 North Olney Ave. Cherry Hill, NJ 08003 1-800-257-7797
'52 Pickup' from: Parkway Research Corp. 13802 Chrisman Road Houston, TX 77039 1-800-442-9821	'D-Tox' from: Cleary's Chemical Corporation 178 Ridge Road Dayton, NJ 08810-1501 800-524-1662 www.clearychemical.com

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

Bert McCarty

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Annual Grass and Broadleaf Weed Suppression in Dormant Bermudagrass	sulfometuron (0.047 lb)	Oust 75DG (1 oz)	Oust may be applied once in November to early-February while the bermudagrass is dormant for the control of winter annual grass and broadleaf weeds, and fescue suppression. This treatment may delay greenup of the bermudagrass. This treatment should eliminate the need to mow the winter weeds. It also will help to suppress bahiagrass. Sulfonylurea family.
	glyphosate (0.38 to 0.5 lb)	Roundup Pro 4L + others (12 to 16 fl oz)	Glyphosate may be applied once in January to early-March while the bermudagrass is dormant for the control of winter annual grass, tall fescue, and broadleaf weeds. Glyphosate does not provide residual control. Amino Acid Derivative family
	glyphosate (0.25 lb) + sulfometuron (0.012 lb)	glyphosate 4L (8 fl oz) + Oust 75DG (0.25 oz)	Glyphosate and Oust may be tank-mixed to be applied once in December to early-March while the bermudagrass is dormant for the control of winter annual grass and broadleaf weeds. This treatment should eliminate the need to mow the winter weeds. It will also help to suppress bahiagrass. Bermudagrass greenup may be delayed with this treatment.
	glyphosate (0.25 lb) + sulfometuron (0.012 lb) + chlorsulfuron (0.012 lb)	glyphosate 4L (8 fl oz) + Oust 75DG (0.25 oz) + Telar 75DG (0.25 oz)	Glyphosate + Oust + Telar may be applied once in December through early-March while the bermudagrass is dormant for the control of winter annual grasses and broadleaf weeds. This treatment should eliminate the need to mow winter weeds. It will also help to suppress bahiagrass, and control ryegrass, mustards and thistles. Bermudagrass greenup may be delayed by this treatment.
	glyphosate (0.3 to 0.6 lb) + 2,4-D amine (0.48 to 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Campaign may be applied once for the control of winter annual grass and broadleaf weeds before bermudagrass greenup. It may also suppress or control broadleaf weeds tolerant of these other treatments. Refer to the label for rates for particular species. It is not necessary to add a surfactant to Campaign. Since Campaign is a formulation containing 2,4-D, use special precautions when applying in the vicinity of 2,4-D sensitive crops such as vegetables, tobacco, fruit trees, ornamentals and cotton.
	imazapic (0.125 to 0.188 lb)	Plateau 2L (8 to 12 fl.oz.)	Controls tall fescue, annual ryegrass, and winter annuals. Avoid application during bermudagrass greenup. Will injure green bahiagrass at these rates. Do not exceed 12 oz per acre in one year. See labeled for recommended additive. Sold only directly to governmental and educational institutions. Imidazolinone family.
	imazapic (0.091 to 0.183 lb) + glyphosate (0.188 to 0.375 lb)	Journey 2.25 L (16 to 32 fl oz.)	Controls tall fescue, ryegrass, winter annuals and specific perennial weeds (see SPECIAL WEED CONTROL section on label for rate for specific weed). See label for recommended tank mixes for additional weed control. A methylated seed oil concentrate at 1.5 to 2 pints per acre can be added to enhance control of specific weeds. Early spring applications made prior to full green-up may delay bermudagrass green-up.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	aminopyralid (0.06 to 0.11) + glyphosate (0.25)	Milestone 2L (4 to 7 oz) + glyphosate 4L (8 fl oz)	Controls numerous broadleaf weeds such as horseweed, dogfennel, horsenettle, thistles and tropical soda apple. Milestone is non-volatile, but use care when applying in the vicinity of broadleaf crops, fruit trees, and ornamentals. Milestone can be tank-mixed with other herbicides such Plateau, MSMA, 2,4-D, triclopyr, and numerous other products labeled for use on grass roadsides to increase weed spectrum. Add a nonionic surfactant at 0.25% v/v to the spray mix.
	diflufenzopyr (0.05 to 0.125) + dicamba (0.1 to 0.25)	Overdrive 76DF (4 to 8 oz)	Controls annual and perennial broadleaf weeds. Add a nonionic surfactant at 0.25% v/v or methylated seed oil at 2 pts per acre to the spray mix. Diflufenzopyr often improves the activity of "auxin-like" herbicides such as triclopyr, clopyralid, and picloram. Max be tank-mixed with Garlon 4 and 3A, 2,4-D, Plateau, glyphosate, Escort, Oust, Telar, and MSMA to increase spectrum of weed species controlled. Overdrive is rainfast within 4 hours after application.
Weed Control in Actively Growing Bermudagrass	MSMA (2 lbs) **or** DSMA (3.6 lbs)	MSMA 6 L (a gal) **or** DSMA 3.6 L (1 gal)	May be applied during summer months every 4 to 6 weeks for suppression or control of emerged weeds. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, broomsedge, johnsongrass, and several broadleaf weeds. Organic Arsenical family.
	diflufenzopyr (0.05 to 0.125) + dicamba (0.1 to 0.25)	Overdrive 76DF (4 to 8 oz)	Controls annual and perennial broadleaf weeds. Add a nonionic surfactant at 0.25% v/v or methylated seed oil at 2 pts per acre to the spray mix. Diflufenzopyr often improves the activity of "auxin-like" herbicides such as triclopyr, clopyralid, and picloram. Max be tank-mixed with Garlon 4 and 3A, 2,4-D, Plateau, glyphosate, Escort, Oust, Telar, and MSMA to increase spectrum of weed species controlled. Overdrive is rainfast within 4 hours after application.
	nicosulfuron (56%) + mesulfuron (15%) (0.044 to 0.067 lb)	Pastora 71DF (1.0 to 2.0 oz)	Especially useful for postemergence sandspur control in bermudagrass. Add a nonionic surfactant at 0.25%v/v. Urea ammonium nitrate at 2 qts/acre may increase weed control and/or reduce bermudagrass injury.
	aminopyralid (0.06 to 0.11)	Milestone 2L (4 to 7 oz)	Controls numerous broadleaf weeds such as horseweed, dogfennel, horsenettle, thistles, and tropical soda apple. Milestone is non-volatile, but use care when applying in the vicinity of broadleaf crops, fruit trees, and ornamentals. Milestone can be tank-mixed with Plateau, glyphosate, MSMA, 2,4-D, triclopyr, and numerous other herbicides labeled for use on grass roadsides to increase weed spectrum. Add a nonionic surfactant at 0.25% v/v to the spray mix. Pyridine family.
	glyphosate (0.19 to 0.3125 lb)	Roundup Pro 4L + others (6 to 10 fl oz)	May be applied during summer months to suppress or control emerged weeds and to release well-established and actively growing bermudagrass. Some discoloration of bermudagrass may occur. Do not exceed recommended rate. For bahiagrass growth and seedhead suppression, apply a second application at 4.0 fl.oz. product/acre 6 to 8 weeks after the initial application. Amino Acid Derivative family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	imazapic (0.047 to 0.0625 lb)	Plateau 2L (3.0 to 4.0 fl oz)	Apply after full spring green-up of bermudagrass or during the summer months to suppress bahiagrass growth and seedhead development. Controls tall fescue, annual ryegrass, and winter annuals. Add a nonionic surfactant at 0.25% v/v or methylated seed oil at 1.5 to 2.0 pts./acre to the spray mix. Do not apply immediately before or during bermudagrass green-up. A second treatment may be applied 6 to 10 weeks for continued growth suppression. For johnsongrass control, use 8 to 12 oz per acre when plants are 18 to 24 inches tall. Tank mixing with MSMA at 2 lbs ai/acre increases the spectrum and level of weed control and often eliminates a mid-summer application and reduces turf injury. This tank mix increases control of johnsongrass and dallisgrass. Imidazolinone family.
	imazapic (0.047 to 0.125 lb) + glyphosate (0.094 to 0.25 lb)	Journey 2.25 L (8 to 16 fl oz.)	Controls tall fescue, summer annuals and specific perennial weeds (see SPECIAL WEED CONTROL section on label for rate for specific **weeds).** Apply **before** weeds reach 6 inches in height. See label for recommended tank mixes for additional weed control. A methylated seed oil concentrate at 1.5 to 2 pints per acre can be added to enhance control of specific weeds. Some yellowing of unimproved common bermudagrass turf may occur with application during the growing season. Yellowing will usually disappear in 2 to 4 weeks under favorable weather conditions. Bahiagrass will be severely injured or controlled at these rates.
	sulfometuron (0.023lb)	Oust 75DG (0.5 oz)	Oust may be applied after full spring green-up of bermudagrass to suppress bahiagrass growth and seedhead development and for the control of certain broadleaf weeds and johnsongrass. A second treatment may be applied about 6 to 10 weeks later for continued suppression. Be certain that no bermudagrass injury is present before applying the second application. Add 2,4-D + dicamba at 1 to 2 qt/acre to increase broadleaf weed control spectrum. Provides poor control of vaseygrass, broomsedge, and dallisgrass. A nonionic surfactant at 0.25% v/v should be added to the spray mix. Sulfonylurea family.
	glyphosate (0.19 lb) + sulfometuron (0.012 lb) **or** MSMA (2 lb) + sulfometuron (0.012 lb)	Roundup Pro 4L + others (6 fl oz) + Oust 75DG (0.25 oz) **or** MSMA 6L (a gal) + Oust 75 DG (0.25 oz)	Glyphosate + Oust or MSMA + Oust may be applied to bermudagrass to provide bahiagrass seedhead inhibition, vegetative suppression and johnsongrass control. Apply after full greenup of bermudagrass and bahiagrass or after the bahiagrass has been mowed. Application should be made prior to seedhead emergence. Repeat application of the glyphosate + Oust tank-mix during the growing season are not recommended. A sequential application of MSMA, or DSMA may be needed later in the summer if seedheads or weeds begin to appear. If bermudagrass is present, this treatment allows it to gradually become the dominant grass.
	metsulfuron	Escort 60DF (0.5 to 1 oz)	For bahiagrass, ryegrass, and hemp sesbania control. Add 1 qt. surfactant per 100 gal spray. Common, Argentine, & Paraguayan bahiagrass cultivars are not as susceptible as Pensacola. Also control foxtails and certain broadleaf weeds such as chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic. Sulfonylurea family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	glyphosate (0.3 + 0.48lb) + 2,4-D (0.45 + 0.72 lb)	Campaign 3.1L (1 to 1½ qts)	Campaign may be applied to actively growing well established bermudagrass and bahiagrass to suppress or control emerged weeds and to allow the release of the bermudagrass. Use the low rate on bahiagrass. This treatment will control many broadleaf weeds tolerant of MSMA, DSMA, glyphosate, or glyphosate + Oust due to the 2,4-D. Rate of application should be based on the weed species most common on the roadside (Refer to label). It is not necessary to add a surfactant to Campaign. Since Campaign is a formulation containing 2,4-D, use care when applying in the vicinity of 2,4-D sensitive crops such as vegetables, cotton, tobacco, fruit trees, and ornamentals.
Grass Weed Control in Centipedegrass	imazapic (0.0625 lb)	Plateau 2L (4 fl oz)	Apply after greenup. Do not apply to drought stressed centipedegrass. Add 0.25% nonionic surfactant. Will provide suppression of many broadleaves. Imidazolinone family.
	sethoxydim (0.19 to 0.28 lb)	Vantage 1.0L (1½ to 2¼ pt)	Vantage may be applied to centipedegrass roadsides to suppress most annual and perennial grasses except dallisgrass. Repeat applications will be needed to suppress bahiagrass or bermudagrass. Apply in 30 to 40 gallons of water per acre. Vantage will not suppress or control broadleaf plants which may be released due to the suppression of grassy weeds. Cyclohexendione family.
	metsulfuron (0.01 to 0.02 lb)	Escort 60DF (¼ to 1 oz)	Note the low use rate. Best control for bahiagrass. A nonionic surfactant at 0.25% by volume (1 qt/100 gal) increases control. Common, Argentine, & Paraguayan bahiagrass cultivars are not as susceptible as Pensacola. Also control foxtails and certain broadleaf weeds such as chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic. Sulfonylurea family.
General Broadleaf Weed Control including thistles	dicamba (0.5 to 1.0 lb)	Vanquish 4S or Banvel 4S (1 to 2 pts)	Add 1 to 2 qts nonionic surfactant per 100 gal of water. Apply March through July in 20 to 40 gal water per acre as a broadcast application or 100 gal per acre as a handgun or backpack application. Add a tracker dye and drift control agent. Avoid drift especially near sensitive crops. Do not apply within the rootzone of ornamentals. Controls many broadleaf weeds including white clover, spurge, thistles, woodsorrel. Treat small (3-in) tall weeds for best control. May be tank mixed with 2,4-D, Princep, Garlon and other herbicides to broaden weed and brush control spectrum. See label for instruction. Synthetic Auxin family.
	diflufenzopyr (0.05 to 0.1) + dicamba (0.125 to 0.25)	Overdrive 70 WG 4 to 8 oz	Controls many annual, biennial broadleaf weeds and controls or suppresses many perennial broadleaf weeds. For effective thistle control, apply when in the rosette stage in spring, to early summer but before bud stage. Also controls ragweed, marestail, kochia, and prickly lettuce. A maximum of 10 oz can be applied per season per treated acre in railroad, utility, pipeline, highway right-of-ways, and other noncropland sites. Use higher rate when treating large annuals/biennials and perennial weeds. An 80% active nonionic surfactant at 1 qt/100 gals or MSO at 1.5 to 2 pt/acre must be used to achieve consistent weed control. To complement weed spectrum or increase weed control, Overdrive can be tank mixed with various herbicides (see label for tank mix options).
	aminopyralid (0.06 to 0.11)	Milestone 2L (4 to 7 oz)	Controls numerous broadleaf weeds such as horseweed, dogfennel, horsenettle, thistles and tropical soda apple. Milestone is non-volatile, but use care when applying in the vicinity of broadleaf crops, fruit trees, and ornamentals. Milestone can be tank-mixed with Plateau, glyphosate, MSMA, 2,4-D, triclopyr, and numerous other herbicides labeled for use on grass roadsides to increase weed spectrum. Add a nonionic surfactant at 0.25% v/v to the spray mix. Pyridine family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	triclopyr (1.5 lbs)	Garlon 3A (2 qts) or Garlon 4 (1.5 qts)	Apply to actively growing plants. Add 2 to 4 qts. nonionic surfactant per 100 gals of spray. May be tank mixed with 2,4-D or fluroxpyr to broaden spectrum of weed control. Synthetic Auxin family.
	2,4-D amine (1 to 4 lb)	2,4-D amine (1 to 4 qts)	Controls most annual and perennial broadleaf weeds. Apply as a foliar spray in 30 gal water per acre to young, actively growing vegetation as a broadcast application. Add a drift control agent and be aware of nearby susceptible crops and other desirable vegetation. Synthetic Auxin family.
	glyphosate (0.3 to 0.6 lb) + 2,4-D amine (0.48 to 0.95 lb)	Campaign 3.1L (1 to 2 qts) LandmasterII 2.2L (27 to 80 oz)	Apply prior to green-up for non-selective control of winter weeds, tall fescue, and some weeds resistant to sulfonylurea herbicides. Add a drift control agent and be aware of nearby sensitive crops and desirable vegetation.
	clopyralid (0.28 to 0.5 lb)	Transline 3L (12 to 21 oz) Stinger 3L (12 to 21 oz)	Add 1 to 2 qts of nonionic surfactant to 100 gal of solution. Apply March through early May for winter broadleaf weeds and late June to early October for summer broadleaf weeds. Apply in 20 to 40 gal water per acre as a broadcast application or 100 gal per acre as a handgun or backpack application. Add a tracker dye and drift control agent. Controls kudzu, locust, redbud, mimosa, clover, sericea lespedeza. Synthetic Auxin family.
	fluroxypyr (0.12 to 0.5)	Vista 1.5L (10 to 43 oz) Vista XRT 2.8L (5.5 to 23 oz)	Especially useful for lespedeza control as well as ragweed, goldenrod, blackberry, kochia, dandelion, thistles and others. Tank mix with 2,4-D or triclopyr to broaden spectrum of weed control
Kudzu	aminopyralid (0.11)	Milestone 2L (7 oz)	Used as a broadcast or spot treatment. Apply during periods of active Kudzu growth. Add a nonionic surfactant at 0.25% V/V to the spray mixture. Do not use this product on areas where broadleaf plants, including legumes, are desired. Total application rate should not exceed 7 oz/acre per year.
	clopyralid (0.5 lb)	Transline 3L (21 oz)	Used as a broadcast or spot treatment. Add 1 pt nonionic surfactant in 50 to 100 gals water. Apply during periods of active growth from June to Sept. Will also kill locust, redbud, mimosa trees, clover, sericea lespedeza. Synthetic Auxin family.
	triclopyr (see trade name rates)	Garlon 3A (1½ to 2 gal)	Amine formulation. Used as a spot or broadcast treatment. Add 1 to 2 pts surfactant per acre. Coverage should be to wet all leaves, stems, and root collars. Best control is with mid- to late-summer treatments (June to Sept).
		Garlon 4 (1 gal/100 gal solution)	Ester formulation. Used as a spot treatment in 20 to 100 gal water per acre. Add 1 to 2 qts surfactant. Best control is with mid- to late-summer treatments (June to Sept). Refer to label for application guidelines. Synthetic Auxin family.
	metsulfuron (0.045 lb)	Escort 60DF (3 to 4 oz)	Note the low use rate. Add 1 to 2 qt surfactant per 100 gal spray mix. Do not treat desirable bahiagrass. For handgun application, use 100 to 150 gal of spray mix per acre. Use 20 to 40 gal per acre for broadcast application. Thoroughly spray foliage and stems without excessive runoff. Sulfonylurea family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Bahiagrass Seedhead Suppression	imazapic (0.03135 to 0.0625 lb)	Plateau 2L (2 to 4 oz)	Foliar (primarily) and root absorbed. Add 1 qt/100 gal nonionic surfactant. Apply to bahiagrass in spring before seedhead formation or 7 days after mowing. Provides some broadleaf weed and nutsedge control. Do not apply to wetlands or to turf less than 3 years old. The 2 oz rate will provide partial control and minimal injury. At the 4 oz rate, treated areas may appear less dense and temporarily discolored, thus, raise the mowing height prior to this treatment. Do not use on St. Augustinegrass or drought- stress bahiagrass. Read and follow label directions before use. Imidazolinone family.
	glyphosate (0.18-0.22 lb) glyphosate + 2,4-D	Roundup Pro 4L (4 to 8 fl oz/10-25 gal water) Campaign 3.1L (16 to 24 oz/A)	Foliar absorbed. Apply to bahiagrass only. Add 2 qts nonionic surfactant per 100 gals spray. Note: Glyphosate is a nonselective herbicide if applications exceed these recommended rates. Make application after full greenup of bahiagrass (timing will vary across the state). Treated areas may appear less dense and temporarily discolored. Initial application of Roundup 4L or generic glyphosate (4L) at 8 oz/A followed by 4 to 6 oz/A 6 weeks later has provided good results. Read and follow label recommendations prior to use. Amino Acid Derivative family.
	sulfometuron (0.023 lb)	Oust 75 DG (½ oz/a)	Foliar absorbed. Applied after full spring green-up or 7 to 14 days after first mowing to suppress bahiagrass growth and seedhead development and for the control of certain broadleaf weeds. A second treatment may be applied about 6 to 10 weeks later for continued suppression. Often tank-mixed with Roundup or Campaign. Treated areas may appear less dense and temporarily discolored. Sulfonylurea family.
Bahiagrass and Weed Suppression in <u>Actively Growing Fescue</u>	MSMA (2 lbs) or DSMA (3.6 lbs)	MSMA 6 L (1/3 gal) or DSMA 3.6 L (1 gal)	Mow roadsides, if needed, when bahiagrass or dallisgrass seedheads begin to appear (usually in early June). Begin treatment when grasses begin to send up new seedheads. Air temperature in afternoons should be 80 degrees or above. Apply as needed when new seedheads or other weeds emerge usually at 4 to 6 week intervals. Two or three applications during the summer will be needed. This treatment suppresses bahiagrass, dallisgrass, johnsongrass and broadleaf weeds and allows fescue to remain with little injury. If bermudagrass is in the roadside, fescue may be gradually replaced. Organic Arsenical family.
Tall Fescue Seedhead Suppression and Weed Control	glyphosate (0.19 to 0.25 lb) + sulfometuron (0.012 lb)	Roundup Pro 4L + others (6 to 8 fl oz) + Oust 75DG (0.25 oz)	Glyphosate + Oust may be applied to tall fescue roadsides to suppress tall fescue seedhead production. Apply to established, actively growing tall fescue in the spring <u>prior to seedhead emergence</u> (usually between March 1 and April 1). Slight discoloration of the fescue may occur. glyphosate + Oust will also help to suppress many broadleaf weeds and grasses. This treatment may eliminate the need for mowing prior to the application of summer fescue treatments that are normally made in May or June. Add 2,4-D &/or dicamba plus 1 qt/acre surfactant to improve broadleaf weed control.
	imazapic (0.0313 to 0.0625 lb)	Plateau 2L (2 to 4 oz)	Add 1 qt/100 gal nonionic surfactant to the 2 oz rate. Surfactant is not needed for the 4 oz rate. May cause temporary injury to turf and thinning of stand. Read and follow label directions before use. Imidazolinone family.
	sethoxydim (0.19 lb)	Vantage 1.0L (1.5 pt)	Vantage may be used to suppress tall fescue seedhead production. Apply to established tall fescue that is actively growing in the spring before the emergence of seedheads (usually between March 1 and April 1.) Do not apply to fescue less than one year old. Apply in 30 to 40 gallons of water per acre. Vantage will not suppress or control broadleaf plants which may be released due to the suppression of tall fescue. Discoloration of the fescue will often occur and may sometimes be severe. Cyclohexendione family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	chlorsulfuron (0.012 lb)	Telar 75DG (0.25 oz)	Telar may be applied to suppress tall fescue seedhead production. Apply to established tall fescue that is actively growing in the spring prior to seedhead emergence (usually between March 1 and April 1). Some suppression of the grass growth may occur. This treatment will also help to suppress or control many broadleaf weeds. This treatment may eliminate the need for mowing prior to the application in the summer of MSMA or DSMA as weed control treatments in fescue. Apply in 20 to 30 gallons of water per acre. Sulfonylurea family.
	glyphosate (0.19 to 0.25 lb) + chlorsulfuron (0.012 lb)	Roundup Pro 4L + others (6 to 8 fl oz) + Telar 75DG 0.25 oz	Glyphosate + Telar may be applied to tall fescue to suppress seedhead production and control some annual weeds. Apply to established tall fescue in the spring prior to seedhead emergence (usually between March 1 and April 1). Make only one application per season. This treatment may eliminate the need for mowing prior to the application of summer fescue treatments that are normally made in May or June. Telar provides better control of thistles and mustards than Oust.
	glyphosate (0.19 to 0.25) + metsulfuron (0.0094 lb)	Roundup Pro 4L + others (6 to 8 fl oz) + Escort 60 DG (0.25 oz)	Glyphosate + Escort may be applied to tall fescue to suppress seedhead production and control some annual weeds. Apply to established tall fescue in the spring prior to seedhead emergence (usually between March 1 and April 1). This treatment may eliminate the need for mowing prior to the application of summer fescue treatments that are normally made in May or June. Do not apply to mixed tall fescue/bahiagrass stands unless bahiagrass control is the desired objective.
	diflufenzopyr (0.05 to 0.125) + dicamba (0.1 to 0.25)	Overdrive 70 WG 4 to 8 oz	Controls many annual and perennial broadleaf weeds. For effective thistle control, apply when in the rosette stage in spring, to early summer but before bud stage. Also controls ragweed, marestail, kochia, and prickly lettuce. A maximum of 10 oz can be applied per season per treated acre in railroad, utility, pipeline, highway right-of-ways, and other noncropland sites. Use higher rate when treating large annuals/biennials and perennial weeds. An 80% active nonionic surfactant at 1 qt/100 gals or MSO at 1.5 to 2 pt/acre must be used to achieve consistent weed control. To complement weed spectrum or increase weed control, Overdrive can be tank mixed with various herbicides (see label for tank mix options) and is rainfast within 4 hours after application.
	aminopyralid (0.06 to 0.11)	Milestone 2L (4 to 7 oz)	Controls numerous broadleaf weeds such as horseweed, dogfennel, horsenettle, and tropical soda apple. Milestone is non-volatile, but use care when applying in the vicinity of broadleaf crops, fruit trees, and ornamentals. Milestone can be tank-mixed with Plateau, glyphosate, MSMA, 2,4-D, and numerous other herbicides labeled for use on grass roadsides. Add a nonionic surfactant at 0.25% v/v to the spray mix.
Limb Trimming (side trimming)	fosamine (6 to 8 lbs)	Krenite 4S (1½ to 2 gal)	Add 1 qt crop oil per 100 gal. spray solution. Only controls treated (sprayed) limbs. Best to treat in late summer (Aug, Sep, Oct). Little foliage brownout occurs after treatment. Leaves drop off the tree in a normal fashion but are not produced the following spring. Use drift control as recommended on label.
	triclopyr (1 to 2 lbs)	Garlon 4 (4 to 8 qts)	This is a dormant application (Feb., Mar., April). Apply within 10 weeks prior to normal bud break. Add 3 gal crop oil per 100 gals spray solution. Only controls treated (sprayed) limbs. Use drift control as recommended on label. Synthetic Auxin family.
Brush Control (foliar)	triclopyr (2 to3% solution)	Garlon 3A (2 gal/100 gal solution)	Used as a spot or broadcast treatment. Add 0.25% surfactant (1 qt/100 gal). Apply during the growing season (May through Sept). Provides selective control of brush and broadleaf weeds such as blackberry, oaks, pines, sumac, and sweetgum. Tank mix with Tordon K to increase weed control spectrum. Also used under guardrails, fences, signs, and bridge ends. Synthetic Auxin family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
		Garlon 4 (1.5 to 3 gal/100 gal solution)	Used as a spot or if stems are too numerous for cut stump application, use as a broadcast treatment. Add 2 gal crop oil concentrate. Apply as a dormant stem and basal season applications (Feb. through April) at 3 gal/acre rate or during late summer 4 to 8 months after cutting and vegetation is actively growing (1.5 gal/acre rate). Also used under fences, culvert ends, delineators, signs, ditches (no standing water present), and bridge ends. Synthetic Auxin family.
	fosamine (6 to 12 lbs)	Krenite 4S (1½ to 3 gal)	Used as a spot or broadcast treatment. Add nonionic surfactant at 1 qt/100 gals. Use 50 gal of water per acre as a broadcast application or 100 gal water per acre as a handgun application. Thorough plant coverage is necessary for control. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Read label for details. Controls kudzu, blackberry, sumac, multiflora rose, pines, and other woody plants.
	glyphosate (2 to 8.1 lb)	Rodeo 5.4L (3 pts to 1½ gal)	Used as a spot or broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal solution. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Thorough plant coverage is necessary for control. Also used for trimming, curbs, gutters, rip-rap, and drainage ditches. Amino Acid Derivative family.
	glyphosate (2 to 5 lb)	Roundup Pro 4L (2 to 5 qts) generic glyphosate 4L (3 to 7 pts)	Used as a spot treatment as treated grass will be damaged. Best results with late summer (Aug to Oct) treatments. Controls most annual weeds and many perennials such as johnsongrass, dock, milkweed, horsenettle, lespedeza, brambles, multiflora rose, and trumpetcreeper. Apply on a spray-to-wet basis. Grass understory will be killed at the base of the spot treatment. Use a drift control agent as recommended on the label. Add 2 to 4 qts nonionic surfactant per 100 gal solution for generic glyphosate. Amino Acid Derivative family.
	glyphosate (5%) + imazapyr (0.5%)	Roundup Pro 4L (5 gal) + Arsenal 2S (2qt/100 gal)	Apply in a low volume backpack sprayer to the point of leaf wet. Do not spray to drip. Special precaution should be followed to avoid root application in areas of desirable trees and minimize the amount of herbicide to soil contact. Weak on waxy leaf brush.
Brambles	triclopyr (see trade name rates)	Garlon 3A (1½ to 3 qts) Garlon 4 (1½ gal/100 gal solution)	Used as a spot treatment. Add 1 to 2 pts surfactant. Coverage should be to wet all leaves, stems, and root collars. Best control when applied in the spring immediately following flowering or in late summer (Aug to Nov). Used as a spot treatment in 20 to 30 gal water per acre. Add 1 to 2 pts surfactant. Treat dormant brush with most of the foliage dropped (Jan through March). Synthetic Auxin family.
	glyphosate (3 to 4 lb) glyphosate (1 to 1.5% solution)	Roundup Pro 4L (3 to 4 qts) Roundup Pro 4L (1 to 1½ gal/100 gal)	Used as a spot treatment after plants have reached full leaf maturity. Best results with late summer (Aug to Nov) treatments. Generic glyphosate 4L may be used as a 1% solution (1 gal/100 gal spray solution). Add 2 to 4 qts nonionic surfactant per 100 gal spray for generic glyphosate. Amino Acid Derivative family.
	metsulfuron (0.023 lb)	Escort 60DF (2 oz)	Note the low use rate. Add 1 to 2 qt surfactant per 100 gal spray mix. Do not treat desirable bahiagrass. For handgun application, use 100 to 150 gal of spray mix per acre. Use 20 to 40 gal per acre for broadcast application. Controls other plants such as hemp sesbania. Thoroughly spray foliage and stems without excessive runoff. Sulfonylurea family.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	fluroxypyr (0.12 to 0.5)	Vista 1.5L (10 to 43 oz) Vista XRT 2.8L (5.5 to 23 oz)	Especially useful for lespedeza control as well as ragweed, goldenrod, blackberry, kochia, dandelion, thistles and others. Tank mix with 2,4-D or triclopyr to broaden spectrum of weed control
Cut stump/stubble	triclopyr (see trade name rates)	Garlon 3A (4 to 6 qts)	Used as a broadcast treatment. Add ¼ to ½% nonionic surfactant. Best results when application is made 4 to 8 months after mowing or hand cutting and vegetation is actively growing. Use drift control.
		Garlon 4 (20% solution = 5 gal/100 gal)	Apply anytime after cutting, including winter months. Used as a individual cut stump treatment. Add 25 gal Basal Oil per 100 gal spray. Used as a spot treatment in a squirt bottle, paint brush, or in a small hand held sprayer. Spray the root collar area, sides of the stump and the outer portion of the cut surface including cambium. Can be used on stumps for several weeks after cutting. Use a oil soluble dye. May be used year-round. May also be used during the dormant season (December through March) instead of Roundup Pro.
	triclopyr (1 lb)	Pathfinder II 1L (100% solution, ready to use)	Apply anytime after cutting, including winter months. Use a back-pack, squirt bottle, or small hand-held sprayer to treat individual cut stumps. Wet the area adjacent to the cambium and bark around the entire circle and the sides of cut stumps. Side stumps (suckers) should be thoroughly wetted down to the root collar area, but not to the point of runoff. Do not treat in standing water which prevents spray from reaching the ground. Do not make applications when snow or water prevent spraying to ground level. Synthetic Auxin family.
	imazapyr (1%)	Stalker 2L (2 qt/50 gal basal oil solution)	Add basal oil as the carrier. Treat immediately following mechanical or hand cutting. Only treat cambium region (outside a perimeter of cut stump) in a low volume backpack applicator. Imidazolinone family.
	glyphosate (50% solution)	Roundup Pro 4L (1:1 water to herbicide ratio)	Treat May through Sept immediately following cutting. Apply using a backpack sprayer or squirt bottle. Remove wood chips before application. Treat only a outside perimeter of cut stump. This is the cambium tissue where the herbicide translocates in the plant. Use a water soluble dye. No drift control agent is needed. Controls oak, sweet gum, and willow. Amino Acid Derivative family.
	picloram (3% ae) + 2,4-D (11.2% ae)	Pathway (see remarks)	Treat the stump as soon as possible after cutting. If more than one hour has elapsed since the time of cutting, use one of the oil-based products. Treat only the exposed cambium area next to the bark and around the entire circumference of the tree with undiluted Pathway.
Injection	2,4-D amine (undiluted injection)	2,4-D amine 4EC (1 to 2 ml of concentrate per injection)	Treat May through October by making injections as near to the root collar as possible. Controls elm, popular, sassafras, willow, and many other woody species. Synthetic Auxin family.
	glyphosate (undiluted injection)	Roundup Pro 4L (1 ml of product per injection)	Inject product into base of tree every 2 to 3 inches around the trunk diameter. Applications should be made during periods of active growth. Controls oak, popular, sweetgum, and sycamore. Amino Acid Derivative family.
Bareground (1 year)	imazapyr (1.0 lb) + diuron (2.4 to 4)	Arsenal 2S (2 qts) + Karmex (3 to 5 lb)	Make broadcast applications in 40 to 50 gal of water per acre. Apply in 100 gal water per acre when using handgun. Controls many annual and perennial broadleaf and grass weeds.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	imazapyr (0.48 to 1 lb) + diuron (3.73 to 8.09 lb)	Sahara DG (6 to 13 lbs)	Tank mix with Roundup Pro for quicker control of emerged vegetation. Do not apply near roots of desirable plants.
	flumioxazin (0.26 to 0.38 lb)	Payload 51WDG (8 to 12 oz)	Provides control of a wide range of grass and broadleaf weeds. Used for guard rails, railroads, substations, industrial plants, farm buildings, fence rows, and storage areas. Apply before weed emergence or to weeds less than 2 inches tall. Add a nonionic surfactant at 0.25% v/v. Yearly allowed rates are 24 oz/acre.
Soil Sterilants (>2 years)	bromacil (6 to 12 lb)	Hyvar X-L (3 to 6 gal)	Apply in 100 to 200 gal of water per acre. Rainfall is required for activation. See label for specific recommendations and weeds controlled.
	bromacil (2.4 to 12 lb) + diuron (2.4 to 12 lb)	Krovar I DF (6 to 30 lbs)	Apply prior to weed emergence. If small weeds exist at time of application, add 1 qt nonionic surfactant per 100 gal of spray solution. Rainfall will be needed to carry herbicide into the root zone of weeds. The length of weed control will be extended as rate is increased. See label for specific recommendations and weeds controlled.
	imazapic (0.183 lb) + glyphosate (0.375 lb)	Journey 2.25 L (32 fl oz.)	Excellent control of most grass and broadleaf weeds. Significant soil residual activity for weeks or months after application. May be mixed with glyphosate 1qt fl oz/A for additional knock down of larger vegetation. For best results, use a MSO at 1.5 to 2 pts/acre.
Johnsongrass in bermudagrass	imazapic (0.188 to 0.375 lb)	Plateau 70DG (4 to 8 oz) or Plateau 2S (8 to 12 oz)	Add 1 qt nonionic surfactant in 100 gals of spray solution. Apply in 20 to 40 gal per acre. Treat from May to Aug when plants are 18 to 24 inches tall. Controls johnsongrass, crabgrass, ragweed, sandspur, ragweed, tall fescue, prickly sida, trumpetcreeper. Use higher rate for later season treatment. To increase control, add MSMA at 2 lbs ai per acre. Do not mow prior to treatment or within 14 days after treatment. Imidazolinone family.
	imazapic (0.123 to 0.183 lb) + glyphosate (0.246 to 0.375 lb)	Journey 2.25 L (21 to 32 fl oz.)	Apply when johnsongrass has reached 18 to 24 inches in height at the whorl. Use higher rate as density increases. Also controls smutgrass, dallisgrass, bahiagrass, vaseygrass and other *Paspalum* spp. For best results, use a MSO at 1.5 to 2 pts/acre.
	asulam (3.3 to 6.7 lb)	Asulox 3.34L (1 to 2 gal)	Broadcast treatment when grass is 18 inches or taller. Use higher rate in heavy infestations. A nonionic surfactant can be added at 0.25% by volume. DO NOT TREAT DESIRABLE CENTIPEDEGRASS.
	glyphosate (0.25 to 1% solution)	Roundup Pro 4L (¼ to 1 gal/100 gal)	Used as a spot treatment after plants have reached 12 to 18 inches in height. Best results with summer (June to Aug) treatments. Use higher rate with larger plants. Will cause temporary discoloration and result in turf thinning.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	glyphosate (0.5 to 3 lb) See Remarks	Roundup Pro 4L (0.5 to 3 qts) See Remarks	Used as a broadcast treatment. Use 1 pt/acre for burndown of smaller plants up to 12 inches tall. Use 2 to 3 qt/acre for larger plants in the boot to head stage. Best results with summer (June to Aug) treatments. Generic glyphosate 4L may also be used as a 0.75% solution (3 qts/100 gal spray) as a spot treatment. Use 3 to 4.5 pts/acre for broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal spray. Treat only actively growing plants (June through September). Will cause temporary discoloration and result in turf thinning.
	glyphosate (0.5 to 0.75 lb) + sulfometuron (0.047 to 0.09 lb)	Roundup Pro 4L (16 to 24 fl oz) + Oust 75DG (1 to 2 oz)	Apply after full greenup of bermudagrass and is actively growing. Repeat application of this tank-mix during the growing season is not recommended. Expect 2 to 4 weeks damage to the bermudagrass. A sequential application of Roundup Pro, MSMA, or DSMA may be needed later in the summer if weeds begin to appear. If bermudagrass is sporadically present, this treatment allows it to gradually become the dominant grass. Apply in 20 to 40 gal water per acre. Do not mow prior to treatment or within 14 days after treatment. Expected control is 80 to 85 % with low rates and 90 to 95% at the high rate.
	MSMA (2 lb) or DSMA (3.6 lb)	MSMA 6 L (a gal) or DSMA 3.6 L (1 gal)	May be applied April through August every 4 to 6 weeks for suppression or control of emerged weeds. Two to 3 applications may be needed for control. Apply in 40 gal per acre. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, johnsongrass, and several broadleaf weeds. Treat when johnsongrass is 12 to 18 in-tall. Tank mixing with Oust at 1 oz/acre during the first treatment will help provide preemergence seedling johnsongrass control. Do not add Oust to subsequent treatments.
	sulfosulfuron (0.035 to 0.062 lb)	Outrider 75 DF (0.75 to 1.33 oz)	Excellent (85 to 95%) for johnsongrass control in bermudagrass. To increase weed control spectrum, add Roundup Pro at 12 to 24 fl oz/acre or MSMA 6L at 3.3 to 4 pts/acre. Add 0.5% nonionic surfactant (2 qts/100 gal spray) or methylated seed oil if Roundup Pro is not used. Treat May through July when plants are small and temperatures above 80F. Sulfonylurea family.
Ryegrass	oryzalin (1.5 to 3 lbs)	Surflan 2AS (3 to 6 qts)	These preemergence herbicides must be applied prior to ryegrass germination, usually by mid-Sept. Tank mix with glyphosate for postemergence control of emerged plants in bahiagrass.
	prodiamine (0.65 to 1.5 lbs)	Endurance 65DF (1 to 2.3 lb)	
	pendimethalin (2 to 4 lb)	Pendulum 60DF (3.3 to 6.6 lb)	
	metsulfuron (0.019 to 0.045 lb)	Escort 60DF (0.5 to 2 oz)	Note the low use rate. Best to apply when ryegrass is immature (Nov. to early Jan.). Do not treat desirable bahiagrass. Sulfonylurea family.
	sulfometuron (0.04 to 0.09 lb)	Oust 75DF (1 to 2 oz)	Do not add surfactant. Controls winter annual broadleaf weeds, ryegrass, fescue, and suppresses early summer annuals. Fall applications compared to later applications, permit earlier spring green-up of bermudagrass. Sulfonylurea family.
	glyphosate (0.3 + 0.6 lb) + 2,4-D (0.48 + 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Apply to dormant bermudagrass before March. High rate is needed unless ammonium sulfate (AMS) is added. With this combination, use Campaign at 1 qt/acre + AMS at 17 lbs per 100 gal of carrier. Apply in 20 to 40 gal water per acre. It is not necessary to add a surfactant to Campaign. Treat small weeds (<6-in tall) for best results. Since Campaign is a formulation containing 2,4-D, use care when applying in the vicinity of 2,4-D sensitive crops such as vegetables, cotton, tobacco, fruit trees, and ornamentals. Control is slow (2 to 4 weeks). Use appropriate drift control agent.

VEGETATION MANAGEMENT AND WEED CONTROL IN SPECIALTY TURF AREAS SUCH AS ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	glyphosate (0.25 lb) + sulfometuron (0.012 lb) + chlorsulfuron (0.012 lb)	Roundup Pro 4L (8 fl oz) + Oust 75DG (0.25 oz) + Telar 75DG (0.25 oz)	Do not use on desirable bahiagrass or tall fescue. Should be used from late Dec through early March for control of annual grasses and broadleaf weeds including mustards and thistles. Roundup Pro can be used alone at 16 oz/a or tank mixed with Oust and Telar for better control of broadleaf weeds. Bermudagrass greenup is not extensively delayed by this treatment. If used on dormant bahiagrass, greenup may be temporarily delayed.
	imazapic (0.091 to 0.183 lb) + glyphosate (0.188 to 0.375 lb)	Journey 2.25 L (16 to 32 fl oz.)	Apply when ryegrass is immature and actively growing. A methylated seed oil concentrate at 1.5 to 2 pints per acre can be added to enhance control. Early spring applications made prior to full green-up may significantly delay bermudagrass green-up. Do not apply during transition if delay in growth and greenup cannot be tolerated. Use on bahiagrass must be done on only dormant turf as use rates listed will severely injury or control bahiagrass. Apply on bahiagrass in late Dec to early Feb. and use lower rate of 16 oz/a, as delayed greenup can be expected.

Note: In portions of the United States, numerous weed species have developed resistance to members of the sulfonylurea herbicide family (e.g. Telar, Oust, and Escort). Roadside managers are encouraged to follow these weed control practices to prevent sulfonylurea resistant weeds. (1) Tank mix sulfonylurea herbicides with herbicides that have a different mode-of action (e.g. Roundup, 2,4-D, etc.). (2) Do not let weed escapes go to seed in areas treated with sulfonylurea herbicide. (3) Respray problem areas with a herbicide that has a different mode-of-action than a sulfonylurea. (4) Rotate the use of sulfonylurea herbicides with herbicides that have a different mode-of-action. Imidazolinone herbicides have the same mode-of-action as sulfonylureas.

[1]Spray equipment must be properly calibrated. A digital speed monitoring device helps maintain the correct ground speed of an application vehicle instead of relying on its stock speedometer. Spray pattern width should be continually monitored throughout the application. Spray pattern bending (distortion) because of excessive ground speeds (∃13 MPH) or wind will shorten spray widths and cause over-application.

[2]Most herbicides should not be treated to drought stressed turf. Excessive turf damage and reduced weed control often results.

SPRAY ADDITIVES

Product	Description	Trade Name Examples
Acidifier	Add to spray mix to lower pH.	PAS-800; Monterey Super 7; pHazol
Activator	Enhances activity of pesticide by enabling improved plant absorption	Surf-King Plus; BIO 90; Delux, Microyl, Pen-A-Trade, Persist, Speed, Bio90
Buffer	Stabilizes tank mix pH and makes it more resistant (buffer) to changes	No Foam A/B, BS-500; Surf-King Plus; Adjust, Buffer-Ten; New Balance
Colorant (dye)	Adds color to spray mix to aid in spray pattern detection	Turf Mark Blue & Green, Green Lawnger, Green Graphics; Blue Dye; Grass Greenzit; Finn Green Plus; Blazon; Gordon's Spray Colorant; H_2O Blue; Mark-It Blue/Green/or Red; Red Dye; Signal; Signal Blue EZ Solupak; Signal Green EZ Solupak; Super Signal Blue/Green; Dy'on
Conditioning Agent	Water-softening agent for hard water	Perc-O-Late; Duke; Request; Spary-Start; Spectra Max Tank Mix; One-Ap XL; N-pHURIC GTO; PAL
Compatibility Agent	Aids in even distribution of incompatible products in a spray tank	MIX; Coblend ES; Blendex VHC; Compex; Convert
Crop Oil	Petroleum-based oils that increase spray penetration through plant leaf cuticle. Methylated seed oils (MSO) are plant-based crop oils.	CMR Herbicide Activator; Peptoil; Primary; Hygrade EC; JLB Oil Plus Majestic; Pure & Simple; Monterey MSO; Crop Oil Concentrate; Persist Ultra; Sunwet
Defoaming/Anti-foaming Agent	Minimizes foaming in the spray tank	Shakedown Liquid; Defoamer; NO FOAM A/B; Foam Buster; Fome-Kil; Concentrated Defoamer; Combat+; Anti-Foam; Ultra 90-NF; Knockdown; Foam-X
Drift-Control Agent (or thickeners)	Reduces spray drift by increasing spray droplet size	Drift Down; AMS Supreme; LOX; Bridle; Confine; Gravity; Spary Start; Ground Zero; STA-PUT; Jetwet DC; Nalco-Tro; Exactrol; MORE; Detain II; Border EG 250; Direct; SANAG 38-F; SANAG 41-A
Spreader/Sticker	An adjuvant that lowers water surface tension and increases spray droplet adherence to the leaf surface	ClearSpray T/O;NO FOAM B; CMR Silicone Surfactant; Pirene II; Surf-King Plus; Hyper-Active; Cohere; Induce; Bio-Film; Rocket DL; Ultra 90-NF; Umbrella; Silicone Super Wetter; Jetwet; Chem-Stik
Sticker/Deposition Agent	Increases adhesion (rain fastness) of spray droplet on plant surface	ClearSpray T/O; AMS Supreme; LOX; LOX Plus; Bind-It; Unbrella; Jetwet; Chem-Stik; Di-aqua
Surfactant/ Spreader/Wetting Agent	Surface-active agents that improves the emulsifying; dispersing, spreading, wetting or other properties of a liquid by modifying its surface characteristics. Wetting agent is a type of surfactant that improves the ability of water to penetrate water-repellent soils, thus, increases infiltration rates. Non-ionic surfactants do not ionize, thus, remain uncharged. These are unaffected by high water levels of Ca, Mg, or ferric ions and can be used in strong acid solutions.	Aqueduct; Dispatch; Primer Select; Sixteen 90; ClearSpray T/O; NO FOAM A/B; CMR Herbicide Activator; CMR Can-Hance; CMR Silicone Surfactant; Haf-Pynt; Sil-Fact; Surf AC820; Surf AC910; Thoroughbred; Joint Venture; Tournament-Ready; Granular; Hydro-Wet; Monterey AgResources; Rocket DL; Torpedo; Ultra 90-NF; Umbrella; Monterey MSO; Crop Oil Concentrate; Magnify; Silicone Super Wetter; Dura Wet; Naiad Liquid Wetting Agent/Pellets/Super Concentrate/Super Pellets/ Super Spreadable; Awuabond; Jetwet; Jetwet HL; Cascade Plus; Duplex; Magnus; Precision EZ Tabs; Oasis; Tension-Aid; Oasis Ultra; Agri-Dex; Aquatrols; Alleviate; Brilliance; Lesco Flow/Wet; Cascade; Cascade Plus; Cohort DC; Dura Wet; Genepol 26-L-80; Induce-F; Infiltrix; Jaf-Pynt; Jetwet HL; PsiMATRIC; EcoWet; Long-Term; Magic-Wet; Monterey AgResources; NoburnN; Pene-Turf; Rely/Rewet; Renex-30; Rocket DL; Short-Term; Surf Side 37A; Timberland 90Torpedo; X-77
Tank Cleaner	Cleans pesticide and fertilizer residues from spray tanks	Neutralize, Nutra-Sol; Tank Cleaner; CMR Pesticide Equipment Cleaner; Tank Cleaner; Tank Cleaner Dry Formulation; K-Klean Liquid Tank and Equipment Cleaner; Incide-Out; Nuway
Thickener	Increases spray droplet viscosity to reduce evaporation & allow more time for leaf absorption	Bridle; Confine; Gravity; First Watch Mosquito Larvicide & Pupacide; Jetwet DC

Guide to Woody Plant Response to Herbicides*

Herbicides	Ash	Bamboo	Birch	Blackberry	Cedar	Chinaberry	Dogwood	Elm	Greenbrier	Hawthorn	Hickory	Honey Locust	Honeysuckle	Kudzu	Maple	Mulberry	Multiflora Rose	Oaks	Persimmon	Pines	Poison Ivy/Oak	Poplar	Privet, Chinese	Sassafras	Sumac	Sweetgum	Sycamore	Trumpet Creeper	Willow
Foliage Application																													
Arsenal	G	G	G	P	P	–	G	P	P	G	G	P	G	P	G	G	G	G	F	P	G	F	G	G	G	G	G	G	G
Banvel/Vanquish	P	P	–	F	F	F	F	F	P	F	P	P	F	G	P	–	F	F	G	G	F	–	P	F	F	F	–	F	F
Crossbow	F	P	F	G	P	G	P	F	P	F	F	F	P	P	F	P	F	F	F	F	F	F	–	F	G	F	F	P	F
2,4-D amine	P	P	F	F	P	P	P	F	P	F	F	P	P	P	P	P	P	F	P	P	P	F	P	P	F	P	F	P	P
2,4-D ester	P	P	–	P	P	P	P	P	P	–	P	P	P	P	P	P	P	P	P	P	P	–	P	P	F	P	–	P	P
Escort	F	P	P	G	P	–	F	F	P	P	P	G	G	G	F	P	F	F	P	P	P	P	P	P	P	P	P	P	P
Garlon 3A	F	P	F	G	P	G	F	F	P	F	F	F	P	F	F	F	F	G	F	G	F	F	P	F	G	G	F	P	F
Krenite	F	P	F	F	P	–	F	F	P	P	P	F	F	G	F	F	F	F	F	G	P	F	–	P	F	F	F	F	F
Roundup Pro/Accord	F	P-F	F	F	P	–	P	F	P	F	P	P	F	F	P	P	F	G	F	P	F	F	G	P	F	F	P	F	F
Transline	P	P	P	P	P	P	P	P	P	P	P	G	P	G	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Weedmaster	P	P	F	F	P	–	P	P	P	F	P	P	F	P	P	P	P	P	F	F	F	F	–	P	F	P	F	F	P
Soil Application																													
Hyvar	F	P	F	F	F	–	F	F	P	F	F	F	P	P	F	F	F	F	P	F	F	F	–	P	F	F	F	P	F
Spike	F	P	F	F	P	–	G	G	F	P	F	G	G	P	F	F	G	G	P	F	P	F	G	P	G	F	F	F	F
Velpar	F	F	F	F	F	G	F	F	P	P	P	G	P	P	F	F	G	G	P	P	F	F	G	P	F	F	F	P	F
Basal Application																													
Garlon 4	F	P	F	G	F	G	G	F	P	F	G	F	P	F	G	F	F	G	F	G	P	F	G	F	G	G	F	P	F
Cut Stump Application																													
2,4-D amine	P	P	F	P	P	–	–	–	–	–	F	F	P	P	P	F	P	F	F	F	F	G	–	G	F	F	F	F	G
Garlon 4	F	P	F	P	F	G	F	F	P	F	F	F	P	F	G	F	F	G	F	F	G	F	G	F	G	G	F	P	F
Roundup Pro/Accord	F	P	F	F	F	–	F	F	P	F	F	F	F	P	F	F	P	G	F	G	G	F	–	F	F	G	G	P	F
Pathway	F	P	F	P	F	–	F	F	P	F	F	F	F	P	F	P	P	F	F	G	P	P	–	P	P	F	P	P	P

*G = Good Control F = Fair (partial control or defoliation) P = Poor Control – =data not available

AQUATIC WEED CONTROL IN IRRIGATION WATER SUPPLIES

Jack Whetstone
(revised by L.B. McCarty)

Aquatic weeds in ponds or lakes used as sources for irrigation water can be controlled by physical removal, biological control, or herbicides. The method, or combination of methods, used will depend on factors such as target weeds, non target plants, and what the water is used to irrigate. Physical removal can be accomplished manually or with machinery. It is time consuming, expensive and normally used alone if other methods are not feasible. However, a certain amount of physical removal may be necessary in combination with the use of biological control and herbicides.

Biological control is an option for certain aquatic weeds. The major advantages are ease of application and no concern over damage to plants irrigated with treated water. Triploid grass carp can control many submerged vascular aquatic weeds. Grass carp are usually used to control all vegetation in a pond, rather than selectively controlling certain vegetation. Replacement stocking of grass carp is necessary when fish are lost. A permit is required to stock grass carp, and only triploid fish can be legally used in SC. Tilapia are stocked in the spring and control most algae species. The concern with tilapia is that they are tropical animals and usually die during cold winters thereby requiring an annual stocking. Tilapia are legal for use in SC. The South Carolina Department of Natural Resources (SC DNR) now requires a free of charge permit prior to stocking tilapia and triploid grass carp for aquatic weed control in SC. A permit can be obtained from SC DNR at 803-734-3891 or from registered dealers in SC. The short permit can be FAXed (803-734-4748) for a rapid turnaround. Check with your Department of Natural Resources to determine if grass carp and tilapia are legal to stock and if a permit is required in your state.

Diquat, endothall, glyphosate, fluridone, triclopyr, copper, sodium carbonate peroxyhydrate, 2,4-D, carfentrazone, imazapyr, penoxsulam, and imazamox compounds can be used safely in ponds used as irrigation sources if the manufacturer's label directions are followed. Certain waiting periods may be required before using water for irrigation after the herbicide is applied, while in some cases waiting periods are not required. Various chemicals have different product formulations; only aquatic labeled pesticides and surfactants/adjuvants may be used in aquatic applications, by law. ***Labels change frequently; refer to the current herbicide label for specific application information. Never exceed the rates recommended on label of the specific product applied. The label is the law.***

Amount of Formulation for Application

Herbicide	**Rate***
Aquathol	0.3 to 2.6 gal/acre foot of 4.2 L or 13 to 108 lb of 10G/acre foot or 2.2 to 22.0 lb of 63G/acre foot.
Carfentrazone	3.4 to 13.5 fl. oz. per surface acre for floating vegetation – 0.286 gal/acre foot for submerged vegetation.
Copper Compounds	0.6 to 3.4 gal of Chelated Copper/acre foot or 0.1 to 0.5 ppm elemental copper.
2,4-D	1 to 2 gal/surface acre of 3.8 L or 150 to 200 lb of 20G/surface acre.
Diquat	1 to 2 gal/surface acre of 2L.
Flumioxazin	6 to 12 oz/surface acre or 200 to 400 ppb for subsurface. Check with Company rep for exact use rates.
Fluridone	0.25 to 0.5 gal/surface acre. Check with Company rep for exact rates.
Glyphosate	4.5 to 7.5 pt/surface acre of 5.4L.
Hydrothol	0.3 to 3.4 gal/acre foot of 2L or 11 to 136 lb of 11G/acre foot.
Imazamox	32 to 64 fl. oz. per surface acre broadcast foliar application. 50 to 500 ppb in water treatment.
Imazapyr	2 to 6 pints per acre.
Penoxsulam	10 to 150 ppb Not to exceed 150 ppb per growing season. Follow label for specific rates.
Triclopyr	2 to 8 quarts per surface acre of 3L.
Sodium Carbonate Peroxyhydrate	3 to 170 pounds per acre-foot of 50G.

*Acre foot = 1 surface acre of water (43,560 ft^2) 1 foot deep.

EFFECTIVENESS OF HERBICIDES FOR AQUATIC WEED CONTROL

Weed	Copper complexes, copper sulfate	2,4-D	Diquat (Reward)	Endothall		Flumioxazin	Fluridone	Glyphosate	Sodium Carbonate Peroxyhydrate	Triclopyr	Imazapyr	Imazamox	Carfentrazone	Penox-sulam
				Aquathol K & G	Hydrothol G & 191									
ALGAE														
Filamentous	E	P	P	–	G	E	P	P	E	–	–	–	–	–
Planktonic	E	P	G	–	G	–	P	P	E	–	–	–	–	–
Branched (Chara)	E	P	G	–	G	–	P	P	P	–	–	–	–	–
Nitella	E	P	G	–	G	–	P	P	P	–	–	–	–	–
FLOATING PLANTS							–							
Bladderwort	P	P	E	–	–	–	E	–	P	–	–	G	–	–
Duckweeds	P	G[1]	G	P	P	E	E	P	P	–	E	–	E	E
Water hyacinth	P	E	E	–	–	–	P	G	P	E	E	E	E	E
Watermeal	P	P	P	–	–	–	G	P	P	–	–	–	G	G
SUBMERSED PLANTS														
Broadleaf watermilfoil	P	–	E	E	E	–	E	P	P	E	–	–	G	E
Coontail	P	G	E	E	E	G	E	P	P	–	–	–	–	–
Egeria	P	P	G	F	F	–	E	P	P	–	–	–	–	E
Elodea	P	–	E	F	F	–	E	P	P	–	–	–	–	E
Eurasian watermilfoil	P	E	E	E	E	G	E	P	P	E	–	F	E	E
Fanwort	P	F	G	E	E	G	E	P	P	–	–	–	–	–
Hydrilla	F[2]	P	G	G	G	G	E	P	P	–	–	F	–	E
Naiads	P	F	E	E	E	G	E	P	P	–	–	–	–	G
Parrotfeather	P	E	E	E	E	–	–	F	P	F	E	G	E	G
Pondweeds (Potamogeton)	P	P	G	E	E	E	E	P	P	–	–	G	–	E
EMERGENT PLANTS														
Alders	P	E	F	P	P	–	P	E	P	–	–	–	–	–
Alligatorweed	P	F	P	P	P	–	G	E	P	E	E	G	G	G
American lotus	P	E	P	P	P	–	F	G	P	E	E	F	–	–
Arrowhead	P	E	G	G	G	–	–	E	P	–	E	–	–	G
Buttonbush	P	E	F	P	P	–	P	G	P	–	E	–	–	–
Cattails	P	G	G	P	P	–	F	E	P	–	E	E	–	–
Common reed	P	P	P	P	P	–	P	G	P	–	E	F-G	–	–
Fragrant & white waterlily	P	E	P	P	P	–	E	E	P	E	E	G	–	–
Frogbit	P	E	E	–	–	–	–	–	P	E	E	E	–	–
Maidencane	P	P	F	–	–	–	F	E	P	–	E	–	–	–
Most grasses	P	P	P	P	P	–	P	G	P	–	E	F	–	–
Pickerelweed	P	G	G	–	–	–	P	F	P	E	E	E	–	G

EFFECTIVENESS OF HERBICIDES FOR AQUATIC WEED CONTROL

Weed	Copper complexes, copper sulfate	2,4-D	Diquat (Reward)	Endothall		Flumioxazin	Fluridone	Glyphosate	Sodium Carbonate Peroxyhydrate	Triclopyr	Imazapyr	Imazamox	Carfentrazone	Penox-sulam
				Aquathol K & G	Hydrothol G & 191									
Pond edge annuals	P	–	G	–	–	–	E	E	P	–	E	–	–	–
Rush	P	P	F	P	P	–	F	E	P	–	E	–	–	–
Sedges and rushes	P	F	F	P	P	–	P	G	P	–	E	–	–	–
Slender spikerush	P	–	G	–	–	–	G	P	P	–	–	F	–	G
Smartweed	P	E	F	–	–	–	F	E	P	E	E	G	–	G
Spatterdock	P	E	P	P	P	–	E	G-E	P	E	E	G	–	–
Southern watergrass	P	P	-	–	–	–	G	E	P	–	–	–	–	–
Torpedograss	P	P	P	–	–	–	F	G	P	–	E	–	–	–
Watershield	P	E	P	–	–	–	G	G	P	–	–	G	–	–
Water pennywort	P	G	G	P	P	G	P	G	P	E	E	E	–	E
Water primrose	P	E	F	–	–	–	F	E	P	E	E	F	G	–
Willows	P	E	F	P	P	–	P	E	P	–	E	–	–	–

E=excellent control (90 to 100%); G=good control (80 to 89%); F=fair control (70 to 79%); P=poor control (<70%). A blank space indicates weed response is not known.
[1]Ester formulations only.
[2]Copper complex only.

For more information on aquatic weed identification and control, these internet sites are recommended:

http://aquaplant.tamu.edu/

http://el.erdc.usace.army.mil/aqua/aqua.html

http://el.erdc.usace.army.mil/aqua/apis/Intro.aspx

http://plants.ifas.ufl.edu/

WAITING PERIOD (DAYS) BEFORE USING WATER AFTER APPLICATION OF HERBICIDES FOR AQUATIC WEED CONTROL

Common Name	Trade Name	Irrigation	Fish Consumption	Watering Livestock	Swimming
Carfentrazone	Stingray	0-14[1]	NR[2]	0 to 1	NR
Copper	Crystalline copper sulfate and various liquid organic copper complexes	NR	NR	NR	NR
2,4-D	Various formulations and manufacturers[3]	Water use restrictions vary by formulation and manufacturer. Certain labels allow irrigation if an approved chemical assay has reached acceptable levels. A few labels allow irrigation with specific waiting periods. Certain labels **may** allow irrigation on established turf, immediately. CHECK INDIVIDUAL LABEL.			
Diquat	Reward	1 to 3[4]	NR	1	NR
	Weedtrine D	5	NR	5	NR
Endothall	Aquathol K	7 to 25	NR	7 to 25	NR
	Aquathol granular	7 to 25	NR	7 to 25	NR
	Aquathol Super K	7 to 25	NR	7 to 25	NR
	Hydrothol 191	7 to 25	NR	7 to 25	NR
	Hydrothol 191 granular	7 to 25	NR	7 to 25	NR
Flumioxazin	Clipper	5	NR	NR	NR
Fluridone	Avast, Sonar AS, Sonar SRP, Sonar PR, Sonar Q	7-30+	NR	NR	NR
Glyphosate	Rodeo, AquaNeat, AquaMaster, AquaPro	NR	NR	NR	NR
Imazamox	Clearcast	See note 5	NR	NR	NR
Imazapyr	Habitat	120	NR	NR	NR
Penoxsulam	Galleon	<30 ppb Turf <1 ppb Others	NR	NR	NR
Sodium Carbonate Peroxyhydrate	Green Clean, Pak 27, Phycomycin	NR	NR	NR	NR
Triclopyr	Renovate 3 & Garlon 3A	120[6]		NR[7]	NR

[1]1 day if <20% of surface acreage is treated. 14 days if >than 20% is treated. Certified lab test of <5 ppb.
[2]NR = No restrictions.
[3]Most formulations do not permit application to ponds used for irrigation or for watering dairy cattle.
[4]Three days for irrigation of turf and nonfood crops; five days for irrigation of food crops (including tobacco) or for preparation of agricultural sprays.
[5]DO NOT use treated water for greenhouses, nurseries or hydroponics - bioassay for canola, onions, potatoes or sugar beets - other crops, 1 day.
[6]No restriction for established grasses and assay to reduce restriction time.
[7]14 day restriction on grazing site and growing. Season grazing restriction on lactating livestock after irrigating pasture.

TANK-MIXING CHEMICALS

Dara Park, PhD and Juang-Horng 'J.C.' Chong, PhD
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Tank-mixing pesticides and fertilizers is a convenient and cost effective way to apply two or more chemicals at once. When done appropriately, tank-mixing can reduce labor and equipment costs, and save time and energy. However, chemicals can potentially react with each other and/or change the characteristics of the carrier water. These interactions can change the efficacy of pesticides in both positive and negative ways:

Positive Effects:

Enhancement occurs when an additive is mixed with a pesticide to provide a greater response than if the pesticide was applied alone. Adjuvants are common enhancements added to tank-mixes. Adjuvants include spreaders, stickers and other materials.

Additive effects result from the addition from each chemical added. The additive effect simply equals the sum of the effect if the chemicals would have been applied alone.

Synergism is when the product of two chemicals interacting with each other provides increased efficacy (control). This may allow for lower rates of chemicals to be used.

Negative Effects:

Antagonism is the opposite of synergism. The components react chemically with each other so one or both chemicals are rendered less effective than if they were applied separately. In addition to poor performance, an increase in plant phytotoxicity may occur.

Incompatibilities can occur from *chemical* reactions as mentioned above, or as the *physical* product of mixing chemicals. For example, if flocculants form, screens and nozzles may be clogged and the desired rate of chemical may not be applied. Flocculants and precipitants can also leave a residue on leaf surfaces. Other *chemical* incompatibilities occur from mixing chemical(s) with inadequate carrier water. Also, carrier water that is too low or high in pH and temperature, contain salts, or organic particulate can chemically alter the compound that is to be applied.

Pesticide resistance to two or more chemicals within a tank-mix may develop if the same chemical combination is used repeatedly over a long period of time. Pests may develop resistance faster when the chemicals used in the same tank-mix are of the same mode of action (for example, cyfluthrin and bifenthrin are both synthetic pyrethroids and target the activity site in an insect's nervous system). Resistance may also occur when the chemicals are of different modes of action if they are used frequently.

To make sure that only positive effects occur when tank-mixing, follow these guidelines for developing new tank-mixes:

1- Know the temperature, pH and salinity of your carrier water. Adjust your carrier water temperature and pH to the optimal range of each chemical before mixing in a spray tank or for a jar test.
2- Read the label of all chemicals products considered to be tank-mixed. The product labels will give you information on what type of chemical and carrier to avoid and potential problems that may occur. If you are still unsure about a mix, contact the manufacturer.
3- Perform a jar test following proper mixing procedures (Table 1). This will determine physical incompatibilities.
4- Many chemicals require constant agitation; be sure to follow all label instructions. Many labels will instruct you in the sequence for adding products to the tank mix.
5- Tank-mix enough to make a test application on part of the target site (preferred) or on a non-target site. Schedule the application to allow enough time for any negative effects (chemical incompatibilities) to be apparent before the actual application is made.
6- When making an actual application, spray as soon as possible. Do not use a spray solution that has been sitting for a long time. Some chemicals may degrade in spray solution after several hours.

Performing a Jar Test

Always wear label required personal protective equipment (PPE) when handling any chemical. When working with mixes of chemicals you must wear the PPE on the label of the most toxic material in the mixture.
Step 1: Measure 1 pint of carrier water in a clear quart jar that is not used for any other purpose.
Step 2: Add ingredients in the proper mixing order (Table 1), stirring each time a new chemical is added. Check for the formation of foam, scum or precipitates after adding each ingredient. It is sometimes necessary to premix some chemicals (some wettable powder (WP), dry flowable (DF), water-dispersing granule (WDG), or liquid flowable formulations as indicated on the labels) *before* adding to the spray tank. *Do not mix the chemicals together without dilution before adding to the jar or spray tank.*
Step 3: Let the mixture sit for 15 minutes. Check for foam, scum and precipitates and other unexpected results or appearance (for example, wettable powders will not dissolve). Feel the side of the jar to gauge temperature. If it is warm, let the jar sit and recheck in another 15 minutes.

Table 1. Proper mixing procedures for tank-mixing chemicals and amount of each chemical needed to perform a jar test.

Order of addition	**Chemical**	**Amount for Jar Test (per 100 gal of final spray volume)**
1	Water conditioning agents and activators	1 teaspoon for each pint
2	Wettable powders and dry flowables	1 tablespoon for each pound
3	Water soluble concentrates or solutions	1 teaspoon for each pint
4	Emulsifiable concentrates	1 teaspoon for each pint
5	Soluble powders	1 teaspoon for each pint
6	Surfactants and oils	1 teaspoon for each pint
7	Fertilizers	proportional

PESTICIDE CALIBRATION FORMULAS AND INFORMATION

Bert McCarty

Acres covered/hour: = MPH x Swath (ft) x 0.1212 or $\frac{\text{MPH x Swath (ft)}}{8.25}$

Gallons Per Acre (GPA):

= $\frac{\text{GPM (whole boom) x 495}}{\text{MPH x Swath (ft)}}$ or $\frac{\text{GPM per nozzle x 495}}{\text{MPH x nozzle spacing (ft)}}$

= $\frac{\text{GPM per nozzle x 5940}}{\text{MPH x nozzle spacing (inches)}}$ or $\frac{\text{GPM per nozzle x 5940}}{\text{MPH x width of nozzle spray (inches)}}$

= $\frac{\text{fl.oz collected per nozzle in 100 ft x 40.8375}}{\text{nozzle spacing (inches)}}$ or $\frac{\text{fl.oz. collected per nozzle x 4084}}{\text{ft. traveled x nozzle spacing (inches)}}$

= $\frac{\text{gallons collected per nozzle x no. nozzles x 43560}}{\text{ft. traveled x Swath (ft)}}$ or $\frac{\text{gallons per 1000 sq.ft.}}{0.023}$

Gallons per 1000 sq.ft. = 0.023 x GPA

Ounces per 1000 sq.ft. = 2.94 x GPA

Gallons Per Minute (GPM): = $\frac{\text{GPA x MPH x Swath (ft)}}{495}$ or $\frac{\text{fl.oz per minute}}{128}$

= $\frac{\text{GPA x MPH x nozzle spacing (inches) x no. nozzles}}{5940}$

GPM/Nozzle: = $\frac{\text{GPA x MPH x nozzle spacing (inches)}}{5940}$ or $\frac{\text{GPA x MPH x nozzle spacing (ft)}}{495}$

= $\frac{\text{Test jar fl.oz x 0.46875}}{\text{seconds to fill test jar}}$ or $\frac{7.5}{\text{seconds to fill 1 pint (16 fl.oz.)}}$

= $\frac{15}{\text{seconds to fill 1 quart (32 fl.oz.)}}$

Minutes/Acre: = $\frac{495}{\text{MPH x Swath (ft)}}$

Acres covered per tank: = $\frac{\text{Gallons per tank}}{\text{GPA}}$

Minutes/load: = $\frac{\text{gallons/load x 495}}{\text{MPH x GPA x Swath (ft)}}$

Material needed per tank = $\frac{\text{rate/A x gallons/tank}}{\text{GPA}}$

Travel Speed (Miles Per Hour, MPH) = $\frac{\text{Distance traveled (ft) x 0.68}}{\text{time (seconds) to travel distance}}$

Flow Rate (as influenced by pressure):

$$\frac{GPA_1}{GPA_2} = \frac{\sqrt{PSI_1}}{\sqrt{PSI_2}} \quad \text{or} \quad GPA_2 = GPA_1 x \sqrt{\frac{PSI_2}{PSI_1}} \quad \text{or} \quad PSI_2 = PSI_1 x \left(\frac{GPA_2}{GPA_1}\right)^2$$

For any change in travel speed (mph), calculate the resulting GPA_2 by:

$$GPA_2 = \frac{GPA_1 x MPH_1}{MPH_2} \quad \text{or} \quad \frac{GPA_1}{GPA_2} = \frac{MPH_2}{MPH_1} \quad \text{or} \quad MPH_2 = \frac{GPA_1 x MPH_1}{GPA_2}$$

Fluid Application

lbs/acre nutrient applied = 0.226464 x element concentration (ppm) x acre inches of solution applied

PPM = $\frac{1{,}000{,}000 \times \text{lbs ai used}}{\text{gal/tank} \times 8.34}$ or $\frac{\text{wt. of material to be used (lbs)} \times 1{,}000{,}000}{\text{wt. of tank mixture (lbs)}}$

= $\frac{1{,}000{,}000 \times \text{oz commercial material used} \times \%\text{ ai (decimal)}}{\text{gal/tank} \times 8.34 \times 16}$ or $\frac{1{,}000{,}000 \times \text{fl.oz. used} \times \text{lb ai/gal}}{\text{gal/tank} \times 8.34 \times 128}$

lbs nutrients applied/acre = ppm of the element in the water x acre-inches water applied x 0.226464

lb ai to use per tank = $\frac{\text{PPM desired} \times \text{gal/tank} \times 8.34}{1{,}000{,}000}$ or $\frac{\text{ppm desired x gal/tank x 8.34}}{1{,}000{,}000 \times \%\text{ ai}}$

lb commercial material to use per tank = $\frac{\text{PPM desired} \times \text{gal/tank} \times 8.34}{1{,}000{,}000 \times \%\text{ ai (decimal)}}$ or $\frac{\%\text{ desired x gal/tank x 8.34}}{\%\text{ ai (decimal)}}$

fl. oz. to use per tank = $\frac{\text{PPM desired} \times \text{gal/tank} \times 8.34 \times 128}{1{,}000{,}000 \times \text{ai per gal}}$

gal commercial material to use per tank = $\frac{\text{ai (decimal)} \times 8.34 \times \text{gal/tank}}{\text{ai per gal} \times 100}$

% ai in a spray mix = $\frac{\text{lbs. commercial material used} \times \%\text{ ai (decimal)}}{\text{gal/tank} \times 8.34}$

gal commercial material for total treated acres = $\frac{\text{PPM desired} \times \text{GPA} \times \text{acres} \times 8.34}{1{,}000{,}000 \times \text{lb ai/gal}}$

Active Ingredients (ai)

lbs commercial material/acre = $\frac{\text{lbs ai to be applied per acre}}{\%\text{ ai of material}}$

gal commercial material/tank = $\frac{\text{gallons/tank x lb ai to be applied per acre}}{\text{gallons/acre x lbs ai per gallon}}$

gal commercial material/acre = $\frac{\text{lbs ai to be applied per acre}}{\text{lbs ai per gallon}}$

Time (seconds) required to cover a specific distance to obtain a desired speed (MPH).

Desired MPH	Feet per minute	Time Required (Seconds) to Travel a Distance of		
		100 ft.	200 ft.	300 ft.
2.0	176	34	68	102
2.5	220	27	54	81
3.0	264	23	45	68
3.5	308	20	39	58
4.0	352	17	43	51
4.5	395	15	30	45
5.0	440	14	27	41
6.0	528	--	23	34
7.0	616	--	19	29
8.0	704	--	17	26
9.0	792	--	15	23

Metric Prefix Definitions (basic metric unit = 1)

tera	=	10^{12}	deci	=	10^{-1}	**Example (weight):**	**Example (volume):**
giga	=	10^{9}	centi	=	10^{-2}	$1kg = 10^{3}g = 10^{6}mg = 10^{9}\mu g = 10^{12}ng$	$1L = 10^{3}mL = 10^{6}\mu L$
mega	=	10^{6}	milli	=	10^{-3}	$1g = 10^{-3}kg = 10^{3}mg = 10^{6}\mu g = 10^{9}ng$	$1mL = 10^{-3}L = 10^{-6}\mu L$
kilo	=	10^{3}	micro	=	10^{-6}	$1mg = 10^{-6}kg = 10^{-3}g = 10^{3}\mu g = 10^{6}ng$	$1\mu L = 10^{-6}L = 10^{-3}mL$
hecto	=	10^{2}	nano	=	10^{-9}	$1\mu g = 10^{-9}kg = 10^{-6}g = 10^{-3}mg = 10^{3}ng$	
deca	=	10^{1}	pico	=	10^{-12}	$1ng = 10^{12}kg = 10^{-9}g = 10^{-6}mg = 10^{-3}\mu g$	

Approximate Rates of Application Equivalents

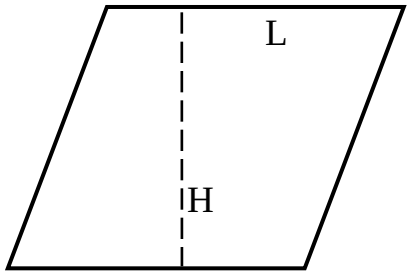
Weights			**Liquid**		
1 oz/ft^2	= 2722.5 lbs/A		1 oz/1000 ft^2	= 43.56 oz/A	= 1.4 qt/A
1 oz/yd^2	= 302.5 lbs/A		1 pt/1000 ft^2	= 5.4 gal/A	
1 oz/100 ft^2	= 27.2 lbs/A		100 gal/A	= 2.3 gal/1000 ft^2	= 1 qt/100 ft^2
1 oz/1000 ft^2	= 43.46 oz/A	= 2.72 lbs/A			
1 lb/A	= 1 oz/2733 ft^2	= 8.5 g/1000 ft^2			
100 lb/A	= 2.5 lb/1000 ft^2				
1 yd^3 sand	= 1.3 to 1.5 tons				
1 bushel	= 1¼ ft^3	= 0.046 yd^3			

Helpful Calculations and Formulas:

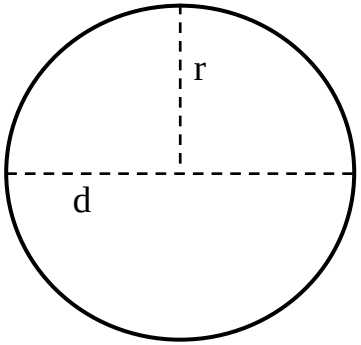
Rectangle, square or parallelogram:	**area**	=	length (L) x width (W)		
Trapezoid:	**area**	=	[a + (b x h)]) 2		
Circle:	**area**	=	radius $(r)^2$ x 3.1416 (or π)	=	diameter $(d)^2$ x 0.7854
	radius	=	d ÷ 2		
	diameter	=	r x 2		
	circumference	=	π x d		
Sphere:	**volume**	=	r^3 x 4.1888	=	d^3 x 0.5236
Triangle:	**area**	=	(W x H)) 2		
Cylinder:	**volume**	=	r^2 x π x L		

Finding Tank Capacity (gallons):

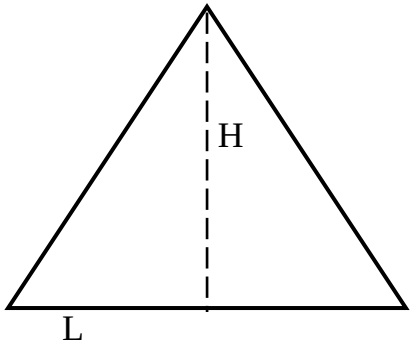
Cylindrical tanks:	**(inches)**	=	L x d^2 x 0.0034
	(feet)	=	L x d^2 x 5.875
Rectangle tanks:	**(inches)**	=	L x W x height x 0.004329
	(feet)	=	L x W x height x 7.48
Elliptical tanks:	**(inches)**	=	L x short diameter (sd) x long diameter (ld) x 0.0034
	(feet)	=	L x sd x ld x 5.875



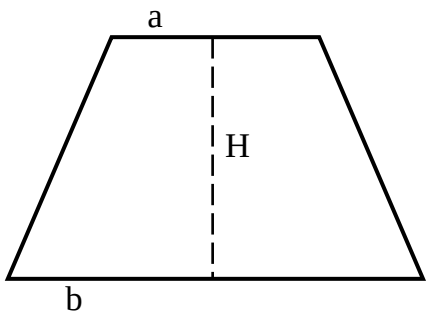
Parallelogram



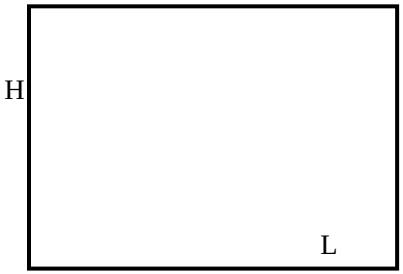
Circle



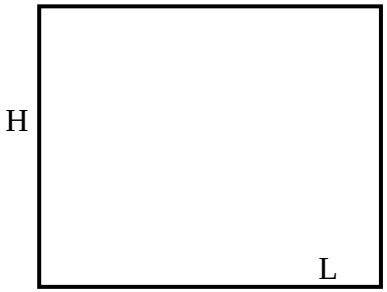
Triangle



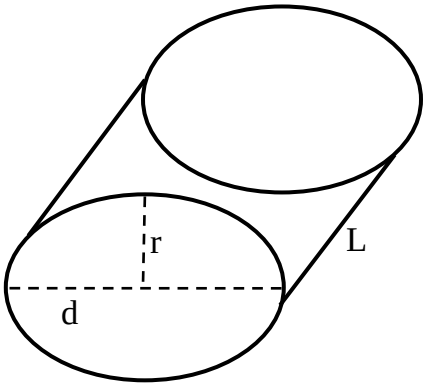
Trapezoid



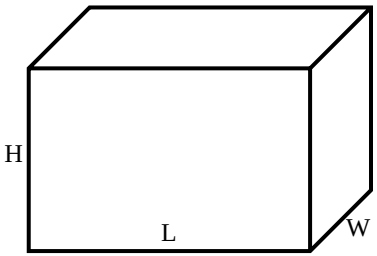
Rectangle



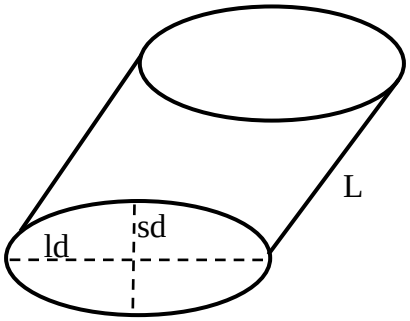
Square



Cylindrical Tank



Rectangular Tank



Elliptical Tank

Metric System Conversion Factors

Area Equivalents

1 acre = 43,560 ft^2 = 4840 yd^2 = 0.4047 hectares = 160 $rods^2$ = 4047 m^2 = 0.0016 sq. mile

1 hectare (ha) = 10,000 m^2 = 100 are = 2.471 acres = 107,639 ft^2

1 cubic foot (ft^3) = 1728 in^3 = 0.037 yd^3 = 0.02832 m^3 = 28,320 cm^3

1 square foot (ft^2) = 144 in^2 = 929.03 cm^2 = 0.09290 m^2

1 acre-inch = 102.8 m^3 = 27,154 gal = 3630 ft^3

1 square meter (m^2) = 10,000 square centimeter (cm^2)

1 cubic yard (yd^3) = 27 ft^3 = 0.765 m^3

1 square yard (yd^2) = 9 ft^2 = 0.836 m^2

Liquid Equivalents

1 ft^3 of water = 7.5 gal = 62.4 lbs. = 28.3 liters

1 acre-inch of water = 27,154 gal = 3630 ft^3

1 liter (l) = 2.113 pts. = 1000 ml = 1.057 qts. = 33.8 fl.oz. = 0.26 gal = 0.0001 m^2 = 1,000 cm3

1 US gallon=4 qt.=8 pt. = 16 cups = 128 fl.oz. = 8.337 lbs of water = 3.785 L = 3785 ml = 231 in^3 = 256 tbsp. = 0.1337 ft^3

1 quart = 0.9463 liters = 2 pt. = 32 fl. oz. = 4 cups = 64 tablespoons (tbsp.)=57.75 in^3 = 0.25 gal = 946.4 ml

1 pint = 16 fl. oz. = 2 cups = 473.2 ml = 32 level tablespoons = 0.125 gal = 0.5 qt

1 cup = 8 fl. oz. = ½ pt. = 16 tablespoons = 236.6 ml

1 tablespoon = 14.8 ml = 3 teaspoons (tsp.) = 0.5 fl.oz.

1 milliliter (ml) = 1 cm^3 = 0.034 fl.oz. = 0.002 pts

1 US fluid ounce = 29.57 ml = 2 tablespoons = 6 tsp. = 0.03125 qt

1 teaspoon = 4.93 ml = 0.1667 fl. oz. = 80 drops

Temperature Equivalents

degrees Centigrade = (°F-32)x5/9

degrees Fahrenheit = (°Cx9/5)+32

Pressure Equivalents

1 lb per square inch (PSI) = 6.9 kilopascal (kPa)

1 PSI = 2.31 feet head of water

1 atm = 760 mmHg = 1.013 x 10^5 Pa = 1.013 bar = 14.70 psi

1 mmHg = 133.32 Pa = 0.133 kPa = 133,333 mPa

1Pa = 10^{-3} kPa = 10^{-6} mPa

1mPa = 10^3 kPa = 10^6 Pa

1kPa = 1cb = 0.001MPa =10 cm H_20 = 10 mbar = 0.01 bar = 1J/kg = 0.0099 atm. = 0.145 psi

Length Equivalents

centimeter (cm) = 0.3937 inch = 0.01 m = 0.03281 ft.

meter (m) = 3.28 feet = 39.4 inches = 100 cm = 1.094 yds = 1000 mm

kilometer = 0.621 statute mile = 1000 meters = 100,000 cm = 3281 ft = 39,370 in.

inch = 2.54 cm = 25.4 mm = 0.0254 m = 0.08333 ft.

foot = 0.3048 meters = 30.48 cm = 12 inches

yard = 0.9144 meters = 3 feet = 36 inches = 91.44 cm

statute mile = 1760 yards = 5280 feet = 1.61 kilometers = 1609 meters

Mixture Ratios

1 mg/g = 1000 ppm

1 fl.oz./gal = 7490 ppm

1 fl.oz./100 gal = 75 ppm

1 qt/100 gal = 2 tablespoons/1.0 gal

1 pt/100 gal = 1 teaspoons/1gal

Flow

1 gpm = 0.134 ft^3/minute = 0.06308 liter/sec

1 ft^3/min. (cfm) = 449 gal/hr. (gph) = 7.481 gal/min

Weight Equivalents

1 ton (US) = 2000 lb = 0.907 metric tons = 907.2 kg

1 metric ton = 10^6 g = 1000 kg = 2205 lb

1 lb = 16 oz = 453.6 grams (g) = 0.4536 kg

1 oz (weight) = 28.35 g = 0.0625 lb

1 gram = 1000 mg = 0.0353 oz = 0.001 kg = 0.002205 lb

milligrams (mg) = 0.001 grams

1 kilogram (kg) = 1000 grams = 35.3 oz = 2.205 lbs

microgram (µg) = 10^{-6} grams = 0.001 mg

nanogram (ng) = 10^{-9} grams = 0.001 micrograms (:g)

picogram = 10^{-12} grams

1 ppm = 0.0001% = 1 mg/kg = 1 mg/L = 1 µg/g = 1µl/l = 1µg/mL = 0.379 g in 100 gal water = 8.34 x 10^{-6} lb/gal = 0.013 fl oz in 100 gal

10 ppm = 0.001% = 10 mg/L

100 ppm = 0.01% = 100 mg/L

1000 ppm = 1 mg/g = 0.1% = 1000 mg/L

1 ppb = 1 µg/kg = 1 µg/L = 1 ng/mL = 1 ng/1,000,000,000

1 ppt = 1 picogram/g

1% = 10,000 ppm = 10g/L = 1g/100ml = 10g/kg = 1.33 oz by weight/gal water = 8.34 lbs/100 gal water

1% (v/v) = 1.28 fl.oz./gal = 1 gal/100 gal

Approximate Weight of Dry Soil

Type	g/cm^3	lbs/ft^3	lbs/acre (6 inches deep)
sand	1.6	100 (or 2700 lbs/yd^3)	2,143,000
loam	1.3 to 1.55	80-95	1,714,000
clay or silt	1.0 to 1.30	65-80	1,286,000
muck	0.65	40	860,000
peat (compact)	0.325	20	430,000

Sand weights (tons): = yd^3 x 1.3

Gravel weights (tons): = ft^3 x 110

-0.5- to 1-inch diameter gravel = 2,700 lbs/ton

-0.25- to 0.375-inch diameter gravel = 3,000 lbs/ton

Approximate Organic Materials for six inch depth per 1,000 sq.ft. (variance in volume of organic materials used may occur).

Desired Organic Materialo Volume in Mix (%)	Approximate thickness applied to soil surfaces (inches)	Organic Material Needed (cu. yd.) per 1,000 sq.ft.
5	0.33	1.0
10	0.67	2.0
15	1.00	3.0
20	1.33	4.0
25	1.67	5.0
30	2.00	6.0

Example: If 10% organic materials is to be incorporated into the top 6-inches of a 1,000 sq.ft. area. From the chart below: the organic material is applied to a depth of 0.67 inches and 2.0 cu. yds. will be needed.

Peat Moss Coverage

Depth (inches)	Coverage (sq.ft.)	
	5.6 cu. ft. Bale (compressed) when loosened covers	4.0 cu.ft Bale (compressed) when loosened covers
0.25	480	346
0.50	240	173
1.00	120	86
2.00	60	43
3.00	40	29
4.00	30	22
6.00	20	14

Conversions for determining turfgrass irrigation needs

1 acre-inch	=	27,154 gal	=	43,560 cu.in.	=	3,630 cu.ft.
1 inch/1000 sq.ft.	=	620 gal	=	83 cu.ft.		
1 gallon	=	0.134 cu.ft.	=	8.34 lbs		
1 million gallon	=	3.07 acre-feet				
7½ gallons	=	1 cu.ft.	=	231 cu.in.		
1 acre-foot	=	325,851 gal	=	43,560 cu.ft.		
1 pound of water	=	0.1199 gal				
Precipitation rate (in/hr)	=	$\frac{\text{gpm x 96.3}}{\text{area (ft}^2\text{)}}$				

Water and Soil Calculations

1 mmhos/cm = 1,000µmhos/cm = 1 dS/m = 1mS/cm

1 meq/L = 1 mmol/L = 1mol/m^3 1 meq/100g = 1mmol/100g = cmol/kg

Energy

1 calorie (cal)	=	4.184 Joule
Joule (J)	=	1 kg m^2 s^{-2}
1 kcal	=	4.184 kJ

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Acres (a)	0.4047	Hectare (ha)
Acres	43,560	Sq. feet (ft^2)
Acres	0.00405	Sq. kilometer (km^2)
Acres	4047	Sq. meter (m^2)
Acres	4840	Sq. yards (yd^2)
Acre-feet	325,851	Sq. feet (ft^2)
Acre-feet	43560	Cu. Feet (ft^3)
Acre-feet	1233.5	m^3
Acre-inch	102.8	m^3
Bar	14.5	lb/in^2
Bar	1019.7	g/cm^3
Bar	29.53	inches Hg @ 0^oC
Bar	75	cm Hg @ 0^oC
Bar	0.001	J/kg
Bar	100	kPa
Bushels (dry)	0.03524	m^2
Bushels	1.245	ft^3
Calorie (cal)	4.184	Joules (J)
Centimeters (cm)	0.03281	Feet (ft)
cm	0.3937	Inches (in)
cm	0.1094	Yards (yd)
cm	0.01	Meters (m)
cm	10	Millimeters (mm)
cm/sec	1.9685	ft/min
cm/sec	0.0223694	MPH
cm^2 (square centimeters)	0.001076	ft^2
cm^2	0.1550	in^2
cm^3 (cubic centimeters)	0.0610237	in^3
cm^3	0.0338	fl oz
Cup	8	fl oz
Cup	236.6	cm^3
Feet (ft)	30.48	cm

Metric Conversion Factors

To Convert	Multiply by	To Obtain
ft	0.3048	m
ft	305	mm
ft^2 (square feet)	929	cm^2
ft^2	0.0929	m^2
ft^2	9.294×10^{-6}	Hectares (ha)
ft^3 (cubic feet)	0.0283	m^3
ft^3	7.4805	Gallons
ft^3	1728	Cubic inches (in^3)
ft^3	0.037	Cubic yards (yd^3)
ft^3	28.32	Liters (L)
ft^3/1,000 ft^2	0.030463	m^3/100 m^2
Feet per minute	0.01136	MPH
Feet head of water	0.433	PSI
Foot candle	10.764	Lux
Gallons (gal)	3.785	Liters
Gal	3785	Milliliters
Gal	128	Ounces (liquid)
Gal	0.13368	ft^3
Gal/acre (gpa)	9.354	Liters/hectare
gpa	0.09354	L/100 m^2
gpa	2.938	oz/1,000 ft^2 (liquid)
Gal/1,000 ft^2	4.0746	L/100 m^2
Gal/minute	2.228×10^{-3}	Cubic feet/second
Gal/min	0.06309	L/sec
Gal/min	0.227125	m^3/hr
Grams (g)	0.002205	Pounds
Gram	0.035274	oz
g/cm^3	0.036127	lb/in^3
g/cm^3	62.428	lb/ft^3
g/ft^2	96	lb/acre
g/ha	0.000893	lbs/acre
g/ha	0.014275	oz/acre

Metric Conversion Factors

To Convert	Multiply by	To Obtain
g/kg	0.10	percent (%)
g/liter	1000	PPM
g/liter	10	Percent
g/liter	0.00834595	lbs/gal
g/liter	0.13351	oz/gal
g/m^2	0.00020481	lb/ft^2
g/m^2	0.20481	lbs/1,000 ft^2
Hectares (ha)	2.471	Acres
Ha	107,639	ft^2
Ha	107.64	1,000 ft^2
horsepower (hp) (electrical or mechanical)	746	watts
hp	550	ft-pounds/sec
hp	1.014	metric horsepower
Inches	2.540	Centimeters
Inches	0.0254	Meters
Inches	25.40	Millimeters
Inches of mercury	3.4	kilopascals (kPa)
in/ft	0.083	mm/mm
in^2	6.4516	cm^2
in^3	16.3871	cm^3
in^3	0.55411	fl oz
in^3	0.01732	qt
Joules per kilograms (J/kg)	1	kPa
kilo Pascal (kPa)	1	J/kg
kPa	1	0.01 bar
kPa	0.01	bar
Kilograms (kg)	2.2046	Pounds
kg/hectare	0.892	Pounds/acre
kg/ha	0.02048	lb/1,000 ft^2
kg/100 m^2	2.048	lbs/1,000 ft^2
kg/L	8.3454	lb/gal
Kilometers (Km)	100,000	Centimeters

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Kilometers	3281	feet
Kilometers	1000	meters
Kilometers	0.6214	miles
Kilometers	1094	yards
Km/h	0.62137	MPH
Km/h	54.6807	ft/min
Kilopascals (kPa)	0.145	lbs/in^2 (psi)
kPa	1	0.01 bar
kPa	1	J/kg
Liters (L)	0.2642	gallons
L	33.814	ounces
L	2.113	pints
L	1.057	quarts
L	0.035315	ft^3
L/m^2	3.2808	$ft^3/1{,}000\ ft^2$
$L/100\ m^2$	0.2454	$gal/1{,}000\ ft^2$
$L/100\ m^2$	1.9634	$pt/1{,}000\ ft^2$
Liters/hectare	0.107	gallons/acre
L/ha	0.0025	$gal/1{,}000\ ft^2$
L/ha	0.314	$oz/1{,}000\ ft^2$
L/ha	0.855	pt/A
L/min	15.85	gal/hr
Meters (m)	3.281	Feet
Meters	39.37	Inches
Meters	1.094	yards
Meters	100	Centimeters
Meters	0.001	Kilometers
Meters	1000	Millimeters
Meters/sec	2.2369	mph
M^2 (square meters)	10.764	ft^2
M^2	1,550	in^2
M^2	1.196	yd^2

Metric Conversion Factors

To Convert	Multiply by	To Obtain
M^3 (cubic meters)	35.3147	ft^3
M^3	1.30795	yd^3
M^3/ha	14.29	ft^3/acre
M^3/ha	0.0122	yd^3/1,000 ft^2
M^3/ha	0.328	ft^3/1,000 ft^2
mil	0.001	inch
mil	0.0254	millimeters
Miles (nautical)	1.1508	Miles (statute)
Miles (statute)	160,900	Centimeters
Miles	5280	Feet
Miles	1.609	Kilometers
Miles	1760	Yards
Miles/hour (mph)	1.467	Feet/second
mph	88	Feet/minute
mph	1.61	Kilometers/hour
mph	0.447	meter/second
mg/kg	1	Parts per million (ppm)
Milliequivalents per liter (meq/L)	1	Millimoles per liter (mmol/L)
Milliequilvalents per 100 g (meq/100g)	Eq. wt. x 10	Parts per million (ppm)
Millimhos per centimeter (mmhos/cm)	1	Decisiemens per meter (dS/m)
mmhos/cm	1,000	Micromhos per centimeter (µmhos/cm)
Milliliters (ml)	0.0338	Ounces (fluid)
ml	0.0002642	Gallons
ml/m^2	3.14	oz/1,000 ft^2
ml/l	0.12793	oz/gal
ml/10,000 L	0.0128	fl oz/1,000 gal
Millimeters (mm)	0.03937	Inches
1 mm Hg @ 0 C	0.13332	kPa
1 mm Hg	133333.3	mPa
Ounces (fluid)	0.02957	Liters
Ounces (fluid)	29.573	Milliliters
Ounces (fluid)	0.03125	qt.

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Oz (fluid)/gal	7.81	ml/L
Ounces (fluid)/acre	0.0731	L/ha
Ounces (fluid)/acre	73.1	ml/ha
Ounces (fluid)/1,000 ft^2	3.18	L/ha
oz (weight)	28.35	Grams
oz (weight)	0.0625	lb
oz (weight)/acre	0.07	kg/ha
oz (weight)/acre	70	g/ha
oz (weight)/1,000 ft^2	3.05	kg/ha
oz (weight)/ft^2	305.15	g/m^2
oz (weight)/gal	7.5	g/L
oz (weight)/1,000 ft^2	0.305	g/m^2
Percent (%)	10	g/kg
Pint (liquid)	0.473	liter
pt/A	1.1692	L/ha
pt/A	0.3673	oz/1,000 ft^2
pt/1,000 ft^2	0.50932	L/100 m^2
Parts per million (ppm)	2.719	lb ai/acre foot of water
PPM	2.0	lbs/acre slice 7-in. deep
PPM	2.25	kg/ha slice 7-in. deep
PPM	0.001	g/L
PPM	8.34	lb/million gal
PPM	1	mg/kg
PPM	0.013	Ounces/100 gal of water
PPM	0.3295	Gal/acre-foot of water
PPM	8.2897	lbs/million gal of water
Pounds (lbs)	0.4536	Kilograms (kg)
Pounds	453.6	Grams
Pounds/acre	1,120	g/hectare
Pounds/acre	1.12	kg/hectare
Pounds/acre	1.0413	g/100 ft^2
Pounds/acre	0.02296	lb/1,000 ft^2

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Pounds/acre	0.112	g/m^2
Pounds/acre-foot	0.3682	g/m^3
Pounds/acre-foot	0.0003682	kg/m^3
Pounds/ ft^2	4883	g/m^2
Pounds/ft^3	16.23	kg/m^3
Pounds/1,000 ft^2	4.88	g/m^2
Pounds/1,000 ft^2	48.83	kg/ha
Pounds/1,000 ft^2	43.5597	lb/A
Pounds/1,000 ft^2	488	g/100 m^2
Pounds/1,000 ft^2	0.4883	kg/100 m^2
Pounds/1,000 ft^2	0.91	lbs/100 yd^2
Pounds/1,000 ft^2	1.1	lbs/1,000 ft^2
Pounds/yd^3	0.0005937	g/cm^3
Pounds/yd^3	594	g/m^3
Pounds/yd^3	0.5932	kg/m^3
Pounds/gallon	0.12	kg/liter
Pounds/1,000 gal	0.12	g/1,000 L
PSI (pounds per square inch)	6.89	Kilopascals (kPa)
PSI	0.06895	Bar
PSI	0.068046	Atmosphere (atm)
PSI	2.31	feet head of water
Quarts	0.9463	Liters
Quarts	946	Millimeters
Qt/A	2.3385	L/ha
Qt/A	0.7346	oz/1,000 ft^2
Qt/100 gal	2.5	ml/L

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Ton (metric)	2,205	lb
Ton (metric)	1,000	kg
Ton (metric)	1.102	ton (2,000 lb)
Yards (yd)	91.44	Centimeters
Yards	0.9144	Meters
Yards	914.4	Millimeters
yd^2	0.836	M^2
yd^3 (cubic yards)	27	ft^3
yd^3	46,656	in^3
yd^3	0.7645	m^3
yd^3	765	L
$yd^3/1{,}000\ ft^2$	0.825	$m^3/100\ m^2$
P_2O_5	0.437	P
K_2O	0.830	K
CaO	0.715	Ca
MgO	0.602	Mg
meq Ca^{+2}/100 g soil	400	lbs Ca^{+2} per acre furrow slice
meq K^+/100 g soil	780	lbs K^+ per acre furrow slice
meq Na^+/100 g soil	460	lbs Na^+ per acre furrow slice
meq Mg^{+2}/100 g soil	109	lbs Mg^{+2} per acre furrow slice
meq Fe^{+3}/100 g soil	372	lbs Fe^{+3} per acre furrow slice
meq Zn^{+2}/100 g soil	654	lbs Zn^{+2} per acre furrow slice
meq H^+/100 g soil	20	lbs H^+ per acre furrow slice
meq Al^{+3}/100 g soil	180	lbs Al^{+3} per acre furrow slice
meq Ca^{+2}/100 g soil	9.2	lbs Ca^{+2} per 1,000 sq.ft. furrow slice
meq K^+/100 g soil	18	lbs K^+ per 1,000 sq.ft. furrow slice
meq Na^+/100 g soil	10.6	lbs Na^+ per 1,000 sq.ft. furrow slice
meq Mg^{+2}/100 g soil	2.5	lbs Mg^{+2} per 1,000 sq.ft. furrow slice
meq Fe^{+3}/100 g soil	8.5	lbs Fe^{+3} per 1,000 sq.ft. furrow slice

Metric Conversion Factors

To Convert	Multiply by	To Obtain
meq Zn^{+2}/100 g soil	15	lbs Zn^{+2} per 1,000 sq.ft. furrow slice
meq H^{+}/100 g soil	0.46	lbs H^{+} per 1,000 sq.ft. furrow slice
meq Al^{+3}/100 g soil	4.1	lbs Al^{+3} per 1,000 sq.ft. furrow slice

Decimal and Millimeter Length Equivalents

Fraction (inch)	Decimals (inch)	Millimeters
1	**1.00**	**25.4**
15/16	0.9375	23.812
7/8	0.875	22.225
13/16	0.8125	20.638
¾	**0.75**	**19.05**
11/16	0.6875	17.462
5/8	0.625	15.875
9/16	0.5625	14.288
½	**0.5**	**12.70**
7/16	0.4375	11.112
3/8	0.3750	9.525
11/32	0.34375	8.731
5/16	0.3125	7.938
9/32	0.28125	7.144
¼	**0.25**	**6.350**
15/64	0.234375	5.953
7/32	0.21875	5.556
13/64	0.203125	5.159
1/5	0.200	5.08
3/16	0.1875	4.762
23/128	0.1797	4.564
11/64	0.171875	4.366
1/6	0.167	4.242
21/128	0.1641	4.168
5/32	0.15625	3.969
1/7	0.143	3.633
19/128	0.1484	3.769
9/64	0.140625	3.572
[	**0.1250**	**3.175**
7/64	0.109375	2.778
1/10	0.100	2.540
3/32	0.09375	2.381

5/64	0.078125	1.984
1/16	0.0625	1.588
3/64	0.046875	1.191
1/32	0.03125	0.794
1/64	0.015625	0.397

Slopes

10%	=	6E	=	10:1	33%	=	18E	=	3:1
18%	=	10E	=	6:1	50%	=	26E	=	2:1
25%	=	14E	=	4:1	100%	=	45E	=	1:1