EC 699

CLEMSON UNIVERSITY

2025
Pest Control Guidelines for Professional Turfgrass Managers

This publication is also available at: https://www.clemson.edu/extension/publications/index.html




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2025 Clemson University Pest Control Guidelines for Professional Turfgrass Managers

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Clemson University Turfgrass Specialist

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.

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Plant Problem Clinic: For identification of all major turfgrass pests, The Clemson University Commercial Turfgrass Clinic is available with excellent resources, diagnostic equipment, and latest control recommendations. More information on this service and how to submit samples can be found on the following website: https://www.clemson.edu/public/regulatory/plant-problem/turf-clinic/index.html

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**
- ✓ **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**
- ✓ **Southern Lawns - EC 707**

Make check or money order payable to the **Clemson University** or for credit card orders call 864-656-3261 during weekday office hours or order on-line at: **http://www.clemson.edu/psapublishing**

Other Turfgrass Publications

✓ **Advanced Turfgrass Management Lab Manual**	This book provides the in-depth knowledge and understanding of the science needed to accomplish desirable turfgrass with minimum inputs. https://www.cambridgescholars.com/product/978-1-5275-7554-7/. **ISBN: 1-5275-7554-3.**
✓ **Common Weeds & Wildflowers, vol I & II**	These two books are the ultimate weed and wildflower ID guides. Color photographs and complete plant descriptions are included. https://www.amazon.com.
✓ **Golf Turf Management**	A complete text covering all agronomic practices for managing golf courses with inputs. Order from https://tinyurl.com/GolfTurfManagement; or crc.com. **ISBN 978-1-138-47638-7.**
✓ **Characteristics of Herbicides for Turf, Ornamental Landscapes, and Aquatics – 3rd edition**	A guide covering all major herbicides used in these markets. The technical information provides successful use of these products including their mode-of-action, herbicide resistance, & herbicide family classification. https://www.amazon.com/dp/B09M59KDCQ. **ISBN 9798757605470**.
✓ **Plants of the Caribbean & Other Tropical Areas**	A color pictorial of the major plants occurring in tropical regions. A complete description and uses are included for each plant. https://www.amazon.com/dp/B09NS4FYDY. **ISBN 979-8784635921**.
✓ **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.**
✓ **Applied Soil Physical Properties, Drainage, & Irrigation Strategies**	A complete text on soil physical properties and implementation for commercial turfgrasses settings such as golf courses and sports fields. The book is available through Springer International Publishing, Switzerland at www.springer.com/us/book/9783319242248. **ISBN 978-3-319-24224-8**.
✓ **Best Management Practices for Carolinas Golf Courses**	A complete text on construction, watering, fertilizing, cultural practices, and pest management strategies for sustainable golf course turf maintenance. http://www.carolinasgcsa.org/default.aspx
✓ **Best Management Practices for Carolina Sports Fields**	A complete text on construction, watering, fertilizing, cultural practices, and pest management strategies for sustainable sports turf maintenance. www.scstma.org

POISON CENTERS

Hunter Taylor
Livestock and Forages Extension Agent, Clemson University Cooperative Extension

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

Poisoning Emergency – ***anywhere in the US*: 1-800-222-1222** General information (Columbia local): 1-803-777-7909 Email: palmettopc@cop.sc.edu Website: https://poison.sc.edu/	Georgia (Atlanta local):1-404-616-9000 Website: **https://www.georgiapoisoncenter.org**

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 your product label), or the NPIC at 1-800-858-7378.

Bulletin 22 – Pesticide Application Notification, Applicator Records Maintenance, and Direct Supervision - In South Carolina, commercial and non-commercial pesticide applicators are required to maintain records on their pesticide applications regardless as to whether products are restricted or general-use pesticides. https://www.clemson.edu/public/regulatory/pesticide-regulation/bulletins/bulletin-22-pesticide-recordkeeping.pdf

Note: Current South Carolina Commercial & Non-Commercial applicators certification period: January 1st, 2024 – December 31st, 2028
Current South Carolina Private applicators certification period: January 1st, 2024 – December 31st, 2028

Note: EPA Soil Fumigation Information website: http://www.epa.gov/soil-fumigants
EPA Region 4 (Southeast) phone number: 800-241-1754

PESTICIDE APPLICATION RECORD

(list farm unit, business name, etc.)

Date: **Time***	**Crop & Target Pest**	**Location***	**Wind Speed/ Direction/ Temp.**	**Brand/Product Name (Active Ingredient)***	**EPA Registration Number***	**# of Units or Acres**	**Total Product Amount (oz, lb, pt, qt, gal)**	**Applicator Information**	**Restricted Re-entry Interval***	
									Duration (Hours)	**Expiration (Mo/Da/Time)**

***Required for Worker Protection**

INSECT CONTROL

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&
Muhammad 'Zee' Ahmed
Assistant Professor

Read pesticide labels and follow label instructions and precautions when handling, mixing, applying and storing pesticides.

INSECT, MITE & OTHER RELATED PEST CONTROL

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[2]The rates were taken from 190 labels, which were hyperlinked to the pesticide trade name.
[3]Use sites: A = athletic or sport fields; C = cemeteries; G = golf courses; L = residential and/or commercial lawns; R = recreational areas and/or parks; S = sod farms. Read label for use sites and restrictions.

Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
Annual Bluegrass Weevil (adult) Annual bluegrass weevil (ABW) is a serious pest of short-mown annual bluegrass (occasionally creeping bentgrass and perennial ryegrass) on golf courses. This species was first reported as a pest in 1931, but it is now widespread throughout the northeastern US (from Maine to eastern OH and northern Virginia). Isolated infestations are also reported in central Wisconsin, northern Kentucky, northeastern Arkansas, and western NC. Several ABW populations have developed resistance to pyrethroids, complicating their management and demonstrating the importance of rotating among insecticides of different modes of action. *Identification:* An adult ABW looks similar to an adult billbug, but smaller (ABW adults average 3.6 mm or 14/100 inch in length). They can be distinguished from billbugs by having antennae that arise from the tip of the snout (billbug antennae arise near the eyes). Mature adult ABW are generally black, covered with fine hairs, and with yellow or whitish "spots" on the body. *Damage and symptoms:* Adults feed on leaf blades of annual bluegrass and bentgrass species, causing notches on the edge of leaf blades or on stems near the base of the leaf. Grass damaged by adults may appear wilted or weakened, but adults rarely kill the infested grass. Turf damage is caused by the grubs. *Life cycle and monitoring:* Monitoring adult activity is crucial to proper timing of insecticide treatment. Adult ABW overwinter in leaf litter on the edge of roughs (overwintering sites) and migrate to fairways in early spring when forsythia is in full bloom. They reach short-mown grass when forsythia flushes out new leaves or dogwood is in full bloom. Two generations develop in a year (spring through fall). Adults from the second generation move back to the overwintering sites. Spring adult migration into the fairways can be monitored using pitfall traps installed parallel to the edge of the fairways. Adults active in turf can be collected with soapy solution flush, using a vacuum, submerging a	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.9 – 1.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	1.4 – 2.94 oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	1.15 – 2.3 lb
		Bifenthrin GC Granules	A, G, L, R, S	1.15 – 2.3 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Capture LFR, Sniper LFR	S	0.1 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.08 – 0.16 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.28 – 0.46 fl oz
		Acelepryn G	A, C, G, L, R, S	1.72 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos SPC 2, SPC 4	G	1.5 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	1.5 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	1.5 fl oz
		Dursban 50W	S	4 Ib/acre

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
piece of turf in lukewarm water (adults float to the top), or finding them in collected clippings. *Treatment threshold and management:* The goal of controlling adult population is to reduce larval damage later in the season. Management of the spring generation is very critical so that larval damage does not become intolerable in the summer. There is no established adult threshold, but some had suggested a threshold as low as 10 adults per sq ft for golf turf. Most often, however, adults are treated at low density to protect high value turf. Adults are typically managed based on trapping, degree-day modeling (such as Syngenta's WeevilTrak), or soon after forsythia achieves full bloom and when flowering dogwood achieves full bract. The second generation can be controlled in late June to early July. Apply adulticides, such as the pyrethroids (IRAC 3A), with sufficient volume to penetrate the thatch layer in greens, collars, tees and fairway perimeters.	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.275 – 0.459 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + alpha-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	indoxacarb (22A)	Provaunt WDG	A, C, G, L, R	0.41 oz
		Provaunt	A, C, G, L, R	0.275 oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	3 – 4 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	7 ml
		Lambda Select	A, G, C, L, R, S	6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	12.8 ml
	mineral oil (UC)	Civitas Turf Defense	A, G	8.5 – 17 fl oz
	thiamethoxam + cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 420 SL	G, L, R	6.9 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.57 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	0.23 – 0.46 fl oz
Annual Bluegrass Weevil (grub or larva) *Identification:* Larvae (or grubs) of the annual bluegrass weevil and billbug are difficult to distinguish. They are creamy white and legless, with a dark brown head. ABW grubs grown from 1 mm (4/100 inch) when first hatched to 4.5 mm (2/10 inch) when mature. *Damage and symptoms:* ABW grubs feed on stems, crowns and roots. After hatching, a grub bores into a stem, and hollows out the stem. The grub then emerges and bores into another stem to continue feeding. A single grub may damage as many as a dozen stems during its development. Mature grub feeds on the crown, and when ready, emerges from the crown and pupates in the soil. The hollowed stems desiccate and die, and they are often filled with sawdust like frass. Damage first appears as small yellow-brown spots on turf. These spots	*Bacillus thuringiensis* subsp. *galleriae*	grubGONE! G	A, C, G, L, R, S	2 lb 5 oz – 3 lb 7 oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	4 – 8 tbsp
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	6 fl oz
		Sevin 7G	A, C, G, L, R, S	3 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.28 – 0.46 fl oz
		Acelepryn G	A, C, G, L, R, S	1.72 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	1.8 – 2.3 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.14 – 0.29 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
coalesce and form a large patch of dead turf. The worst damage often appears in the summer. *Monitoring:* ABW grubs are monitored through examination of soil cores. Samples should be collected from declining turf, not dead turf. *Treatment threshold and management:* Management for ABW begins with the detection and management of adults. Therefore, a successful ABW management program consists of components for both adult and larval controls. Larvicides (often the neonicotinoids or IRAC 4A, or diamide insecticides or IRAC 28) are typically applied 2 weeks to 1 month after adult activity is observed or based on plant phenology (dogwood in full bloom for young larvae and rhododendron in full bloom for older larvae of the spring generation). Larvicides should be applied with sufficient volume to penetrate the thatch. Damage thresholds are 30-80 larvae per sq ft for the spring generation and 10-40 larvae per sq ft for the summer generation.		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.275 – 0.459 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + alpha-cypermethrin (4 + 3)	Alucion 35 WG	G, L, R	0.44 oz
	imidacloprid (4A)	Bandit 0.5 G, Malice 75 WSP, Mallet 0.5 G, Merit 0.5 G	A, C, G, L, R	1.4 – 1.8 lb
		Mallet 7.1% PF	A, C, G, L, R, S	1.38 – 1.8 fl oz
		Midash 2SC, Merit 2F, Mallet 2F, etc.	A, C, G, L, R, S	0.46 – 0.6 fl oz
		ImidaGold 70DF, Merit 75 WP, etc.	A, C, G, L, R, S	3 – 4 tsp / 0.15 – 0.2 oz
		Bandit 0.5 G, Mallet 0.5 G, Merit 75 WSP	A, C, G, L, R, S	0.09 – 0.12 packet, 1.4 – 1.8 lb
	imidacloprid + λ-cyhalothrin (4A + 3A)	Imi+Lambda G	A, L, R	3.4 – 4.6 lb
	indoxacarb (22A)	Provaunt WDG	A, C, G, L, R	0.41 oz
		Provaunt	A, C, G, L, R	0.275 oz
	novaluron (15)	Suprado	A, C, G, L, R, S	2.2 – 3 fl oz
	spinosad (5)	Conserve SC	A, C, G, L, R, S	1.2 fl oz
	Steinernema carpocapsae (UC)	NEMAforce SC	A, C, G, L, R, S	25 million units
	tetraniliprole (28)	Tetrino	A, G, L	0.367 – 0.735 fl oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	2 lb
		Dylox 420 SL	G, L, R	5.2 – 6.9 fl oz
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.57 – 0.80 fl oz
Ant, Red Imported Fire *Damage:* Red imported fire ant (RIFA) is a regulated pest. Movement of soil and sods is regulated by a federal quarantine. If sods are to be shipped outside of the quarantine area (including the entire SC and most of NC), please see https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/imported-fire-ants/CT_Imported_Fire_Ants for regulations on specific quarantine treatments required by USDA-APHIS, or consult with Clemson University Department of Plant Industry or Plant Industry Division of the North Carolina Department of Agriculture and Consumer Services. RIFA poses mainly medical concerns to turf managers and users. Their stings are	abamectin (6)	Abathor, Ascend, Award II Fire Ant Bait	A, C, G, L, R	0.37 oz (broadcast) 5 – 7 tbsp per mound
	acephate (1B)	Acephate Pro 75 SP, Acephate 90 SP	A, G, L, R, S	1 – 2 tsp per mound
		Orthene Turf, Tree, Ornamental WSP	A, G, L, R, S	1 oz in 5 gal (mound)
		Orthene TTO 97, Acephate 97 WDG	A, G, L, R, S	0.75 oz in 5 gal (mound)
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.75 oz in 5 gal (mound)
	acephate + imidacloprid (1B + 4A)	Avatar PLX	A, G, L, R, S	1.5 oz in 5 gal (mound)
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz (broadcast)
	azadirachtin (UN)	AzaGuard	A, C, L, R, S	8 – 21 fl oz (broadcast)
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.135 – 0.27 fl oz (broadcast)
		Tempo Ultra GC	G, A, C, L, R	

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
painful, and some people develop allergic reactions to the stings. Because of their medical importance, RIFA is rarely tolerated in turf. Management often begins as soon as mounds or foraging ants are detected. Because of a lack of reliable biological or cultural control, the management of RIFA on turf relies entirely on insecticide application. *Management:* Chemical management strategies fall largely into three approaches: Individual mound treatment, broadcast bait treatment and broadcast insecticide treatment. Individual mound treatments include liquid drenches, dusting or granular application of insecticides or baits directly to active mounds. This treatment approach is fairly fast acting but only works to reduce activity of the colonies that are treated. Insecticide granules or solution should be applied to the mound, and the area within the radius of at least 3 ft from the mound. This treatment approach is most appropriate for eliminating individual mounds that represent isolated hazards (such as the low number of mounds in a residential lawn) or as clean-up treatments. This approach is not effective as a management strategy for reducing the RIFA population in a large area. Because liquid drenches and granules do not always kill the queen hiding deep within the nest system, individual mound treatment has the greatest risk of population resurgence. Broadcast bait treatments are more effective in reducing the population in a large area. The speed at which the baits reduce mound numbers differs among products. Baits formulated with an insect growth regulator, such as Distance or Extinguish Professional, are slower acting with result becoming noticeable more than three or four weeks after application. Baits formulated with other stomach or neurotoxins, such as Advion and Siesta, act faster and deliver results within one or two weeks. Baits are most effective when applied in the spring and the fall. The key to success is to broadcast the baits when ants are foraging. The best way to determine if ants are actively foraging is to place a small amount of test bait or greasy food items in the area to be treated. Bait can be applied if ants are found feeding on these “sentinel” food items within 30 minutes. If not foraging ants are found, withhold application and use fresh food item to test for foraging activity the next day. RIFA prefers fresh baits. Therefore, it is important to use all baits within the day of opening a bag. Store baits (opened or not) in a cool room to avoid the baits from becoming rancid. Make application to dry turf, and do not water for at least a day after application. Broadcast insecticide treatments are recommended for high use areas with low tolerance for RIFA. Broadcast insecticides may be applied as spray or granular to the turf. Some broadcast insecticides are relatively expensive; therefore, this approach can be cost prohibitive when employed to protect a very large area. Also, broadcast insecticides are usually formulated with stomach or contact insecticides, which kill only the foraging ants. The advantage of broadcast	bifenthrin + novaluron + pyriproxyfen (3A + 15 + 7C)	DuraFlex CS	L	1 – 2 fl oz/gal (mound)
	carbaryl + bifenthrin (1A + 3A)	Duocide	A, L, R	4 – 8 lb (broadcast)
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz (broad, mound)
		Chlorpyrifos SPC 4	G, S	0.75 fl oz (broad, mnd.)
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	1.8 – 2.3 lb (broadcast)
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb (broadcast) 1 tbsp per mound
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb (broadcast)
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb (broadcast)
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.6 – 1 fl oz (broadcast) 1 oz in 1-2 gal (mound)
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.5 – 1 fl oz (broadcast) 1 oz in 1-2 gal (mound)
		Capture LFR, Sniper LFR	S	0.4 fl oz (broadcast) 0.05 fl oz/1-2 gal (mnd.)
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16–0.32 fl oz (broadc.) 0.32 oz/1-2 gal (mound)
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz (broadc.)
		Bifenture EC, Brigade 2EC	S	0.32 fl oz (broadcast) 0.05 fl oz/gal (mound)
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	1.25 – 3.75 fl oz per 10 gal per mound
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	2.3 – 3.6 lb (broadcast) 0.7 oz per mound
		Aloft GC SC	A, C, G, L, R, S	0.33 – 0.46 fl oz (broad.) 1 tsp/gal (mound)
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz (broadcast)
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb (broadcast)
		Suspend SC	L	0.25 – 1.5 fl oz (broadcast)
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz (broadc.)
	fipronil (2B)	Fipronil 0.0143G, TopChoice	A, C, G, L, R, S	2 lb (broadcast)
		Chipco Choice, Fipronil 0.1G	A, C, G, L, R, S	4.6 oz (broadcast)
	fipronil + bifenthrin + lambda-cyhalothrin (2B + 3A + 3A)	Taurus Trio G	A, C, G, L, R, S	2 lb (broadcast)

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
insecticides is high efficacy that can be achieved quickly. The longevity of a broadcast insecticide treatment varies among products, from several weeks to a year. Because broadcast insecticides typically do not kill the queen, the risk for mound resurgence is high. To achieve good control, broadcast insecticides should be applied evenly and thoroughly to cover all areas to be protected. RIFA can build new mounds or forage in untreated areas or areas receiving less than enough insecticides. Combining individual mound treatment and broadcast insecticide treatment based on the management goal for the site is likely to produce better results than using a single insecticide or strategy. The 'two-step' program is a combination of both broadcast bait and individual mound treatments, which is suitable for large and medium-sized areas at a moderate cost. The first step involves broadcasting baits in the spring and/or fall, when the RIFA is actively foraging. Then any visible individual RIFA mounds can be treated with a fast-acting contact insecticide in step two. Many products are available for RIFA treatment. Check label of each insecticide for information on approved use site, application method, yearly application limit and buffer zone restrictions.	hydramethylnon (20A)	Amdro Pro Fire Ant Bait, ProBait	A, C, G, L, R	0.4 – 0.6 oz (broadcast) 2 – 5 tbsp per mound
	hydromethylnon + s-methoprene (20A + 7A)	Extinguish Plus	A, C, G, L, R	3 oz (broadcast) 2 – 5 tbsp per mound
	indoxacarb (22A)	Advion Fire Ant Bait	A, C, G, L, R, S	0.5 oz (broadcast) 4 tbsp per mound
	indoxacarb + novaluron + pyriproxyfen (22A + 15 + 7C)	Doxem Plus Fire Ant Bait	A, C, G, L, R	0.5 oz (broadcast) 0.5 oz per mound
	iron phosphate + spinosad (NC + 5)	Antixx Plus	A, C, G, L, R	0.23 – 1 lb (broadcast) 1.4 – 1.9 oz per mound
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb (broadcast) 1 – 2 tsp per mound
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml (broadcast) 0.5 fl oz/2.5 gal (mound)
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml (broadcast) 0.32 fl oz/2.5 gal (mnd.)
	metaflumizone (22B)	Siesta Insecticide Fire Ant Bait	A, C, G, L, R, S	0.4 – 0.6 oz (broadcast) 2 – 4 tbsp per mound
	permethrin (3A)	Astro	A, C, L, R	4 – 8 fl oz/100 gal (broadcast)
	pyriproxyfen (7C)	Distance Fire Ant Bait	A, C, G, L, R, S	0.35 – 0.5 oz (broadcast) 1 – 4 tbsp per mound
	s-methoprene (7A)	Extinguish Professional	A, C, G, L, R, S	0.27 oz (broadcast) 3 – 5 tbsp per mound
	spinosad (5)	Antixx Liquid Ant Bait	A, C, G, L, R, S	Bait station
		Conserve Fire Ant Bait	A, C, G, L, R, S	1/3 – 2/3 cup (broadcast) 4 – 6 tbsp per mound
		Fire Ant Fighter	L	
		Firefighter Fire Ant Bait	S	
		Conserve SC	A, C, G, L, R, S	0.1 fl oz in 1 gal (mound)
		Entrust SC	A, C, G, L, R, S	0.05 fl oz/gal (mound)
	thiamethoxam (4A)	Meridian 25WG	A, C, G, L, R, S	1 – 3 oz/10 gal (mound)
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz (broadcast) 0.15 fl oz in 2.5 gal (mnd.)
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz (broadc.)
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb (broadcast) 0.5 cup per mound
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin +	Triple Crown Golf	A, C, G, L, R, S	0.46 – 0.8 fl oz (broadc.)

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	imidacloprid (3A + 3A + 4A)	Triple Crown T&O	A, C, L, R	0.8 fl oz/1-2 gal (mound)
	abamectin (6)	Abathor Granular Ant Bait	A, C, G, L, R	0.4 oz (broadcast) 5 – 7 tbsp per mound
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard	A, C, L, R, S	8 – 21 fl oz
	(azoxystrobin) + thiamethoxam (FRAC 11 + IRAC 4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	beta-cyfluthrin (3A)	Tempo Ultra GC	G, A, C, L, R	0.135 – 0.27 fl oz
		Tempo Ultra WP, WSP	A, C, L, R	5 – 10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.5 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 1 fl oz
		Capture LFR, Sniper LFR	S	0.2 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16 – 0.32 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.16 – 0.32 fl oz
	bifenthrin + novaluron + pyriproxyfen (3A + 15 + 7C)	DuraFlex CS	L	1 – 2 fl oz/gal (mound)
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.5 – 0.75 fl oz
		Dursban 50W	S	2 Ib/acre

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	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	2.7 – 3.7 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.22 – 0.29 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + α-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	fipronil (2B)	Fipronil 0.0143G, TopChoice	A, C, G, L, R, S	2 lb (broadcast)
		Chipco Choice, Fipronil 0.1G	A, C, G, L, R, S	4.6 oz (broadcast)
	fipronil + bifenthrin + λ-cyhalothrin	Taurus Trio G	A, C, G, L, R, S	2 lb
	hydramethylnon (20A)	Amdro Pro Fire Ant Bait, ProBait	A, C, G, L, R	0.4 – 0.8 oz (broadcast) 2 – 5 tbsp per mound
	hydramethylnon+imidacloprid (20+4A)	Lava-Lor Granular Bait	A, C, G, L, R	4 – 6 oz
	hydromethylnon + s-methoprene (20A + 7A)	Extinguish Plus	A, C, G, L, R	0.2 – 0.8 oz (broadcast) 2 – 5 tbsp per mound
	indoxacarb (22A)	Advion Fire Ant Bait	A, C, G, L, R, S	0.5 oz (broadcast) 4 tbsp per mound
		Advion Insect Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
	indoxacarb + novaluron (22A + 15)	Doxem IG Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
	indoxacarb + novaluron + pyriproxyfen (22A + 15 + 7C)	Doxem Plus Fire Ant Bait	A, C, G, L, R	0.5 oz (broadcast) 0.5 oz per mound
	iron phosphate + spinosad (NC + 5)	Antixx Plus	A, C, G, L, R	0.23 – 1 lb (broadcast) 1.4 – 1.9 oz per mound
	lambda-cyhalothrin (3A)	Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	malathion (1B)	Malathion 5EC	L	1.4 tsp per gallon
	pyriproxyfen (7C)	Distance Fire Ant Bait	A, C, G, L, R, S	0.35 – 0.5 oz (broadcast) 1 – 4 tbsp per mound
		Archer IGR	L	2 fl oz
	s-methoprene (7A)	Extinguish Professional	A, C, G, L, R, S	0.27 oz (broadcast) 3 – 5 tbsp per mound
	spinosad (5)	Antixx Liquid Ant Bait	A, C, G, L, R, S	Bait station

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.46 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	
Aphids (greenbug) *Identification:* Greenbug is a species of aphid. Adults and nymphs are small, soft bodied, pear-shaped, wingless, light to dark green, and feed on stems and leaves of turfgrass. The tips of legs, tailpipes and antennae are black. *Damage and symptoms:* Greenbug is usually a pest of grain crops but will invade turfgrass. Feeding cause yellow spots on the leaf blades, which eventually coalesce to form a chlorotic leaf. Infested turf becomes thin and chlorotic. Brown patches with a yellow ring eventually appear. *Life cycle and monitoring:* Population begins to build up in the spring and advances through multiple generations. The population is the largest and most damaging in late spring to early summer. Symptoms (yellow or burnt orange color) can be seen on the infested turf easily without any visual aid. The aphids can be found on midvein or stem. *Treatment threshold and monitoring:* No treatment threshold has been established. Few insecticides are labeled specifically for the management of greenbug on turf. The insecticides listed here are for aphid management in general but are expected to perform well against greenbugs. Infestation worsens in well-fertilized turf; therefore, avoid fertilization beyond what's needed.	acephate (1B)	Orthene Turf, Tree, Ornamental WSP	G, S	0.5 oz
		Livid 90 WDG Prill	G	0.4 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.4 – 0.9 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	0.8 oz
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 21 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	3.4 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 Ib/acre
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
Bermudagrass Mite (also zoysiagrass mite & other eriophyid mites)	abamectin (6)	Todal	G	0.3673 – 0.5510 fl oz
		Divanem	G	0.0717 – 0.1435 fl oz
	azadirachtin (UN)	Azatrol EC	A, C, G, L, R, S	1.3 fl oz
	bifenthrin (3A)	Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
Identification: Bermudagrass mite is a serious pest of bermudagrass (common and hybrid), and zoysiagrass mite is a pest of zoysiagrass (both *Zoysia japonica* and *Z. matrella*). Both species belong to the mite family Eriophyidae, which is characterized by their extremely small size (7/1000 inch), elongated or banana-shaped bodies, and living in secluded portions of the host grass (such as between leaf sheath and stem for these two species). *Damage and symptoms:* Bermudagrass mite causes witches' brooms or rosettes on bermudagrass, where internodes are stunted, and all nodes are clumped together. Zoysiagrass mite causes chlorosis on zoysiagrass, and the "buggy whip" symptom where terminal leaf blade is caught in the folded older leaf and bent in the shape of a whip. Infested turf first appears chlorotic. But as distortion and death continues, thinned or bare spots begin to appear. Weeds often invade these thinned or bare spots. *Monitoring:* Infestation is detected by looking for the witches' brooms or buggy whip symptoms. Mites can be seen under the leaf sheaths with magnifier or hand lens that magnify at least 20 times. *Treatment threshold and management:* There is no established treatment threshold. Abamectin is currently the most effective insecticide against bermudagrass mite. Pyrethroids (IRAC 3A) and other insecticides are generally not effective. There is poor understanding of management efficacy against zoysiagrass mite. Increased irrigation often helps turf withstand damage.		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Capture LFR, Sniper LFR	S	0.1 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.08 – 0.16 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	chlorpyrifos (1B)	Chlorpyrifos SPC 2, SPC 4	G	0.75 – 3 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
	chlorpyrifos (1B)	Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 lb/acre
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	novaluron (15)	Suprado	G	2.2 – 3 fl oz
	spiromesifen (23)	Forbid 4F	A, C, G, L, R	1.4 – 4 fl oz/100 gal
	spirotetramat (23)	Kontos (under Section 24(c); FL, SC and TX)	G	5 fl oz/acre
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Billbugs (adult) *Identification:* Billbug adults are weevils; they are generally dark brown or black, with a long snout protruding from the front of the head. Multiple species are active on turf in the Carolinas, with hunting billbug being the most common species. Hunting billbug can be identified based on the pattern of the warts on its pronotum (the segment immediately after the head), which resemble a "Y" flanked by parentheses. *Damage and symptoms:* Billbug adults do not cause significant damage to turf. Adults chew holes on leaf blades and stems, but the damage rarely cause grass	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star	A, C, L, R	1.15 – 2.3 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
decline or death. Larva or grub is the damaging life stage. *Life cycle and monitoring:* Hunting billbug can feed on all turfgrass and many weedy grass species, but damage is most frequently reported for bermudagrass, zoysiagrass (particularly *japonica*) and seashore paspalum. In the Carolinas, billbug adults can often be found walking slowly on turf surface or on pavement near turf in the morning from March to November. There are likely two overlapping generations in the Carolinas, with adults and grubs appearing throughout much of the year. Peak adult activity occurs in May through September. Adults can be monitored by observing for their activity on turf or by pitfall trapping. *Treatment threshold and management:* No treatment threshold has been established and verified for billbugs infesting warm- and cool-season turfgrass. Adults on turf showing infestation symptoms by grubs should be managed. Adult management relies mostly on the application of contact insecticides, such as pyrethroids (IRAC 3A). Adulticides are applied when adults are observed but following up application of larvicides will be needed to substantially reduce billbug population and damage.		Gold G, etc.		
		Bifenthrin GC Granules	A, G, L, R, S	1.15 – 4.6 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc..	A, C, G, L, R, S	0.08 – 0.16 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	4 – 8 tbsp
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.18 – 0.46 fl oz
		Acelepryn G	A, C, G, L, R, S	1.15 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos 1% Mole Cricket Bait	G, S	2.5 lb
		Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 – 1.5 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 – 1.5 fl oz
		Dursban 50W	S	2– 4 Ib/acre
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.184 – 0.367 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	dinotefuran + alpha-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	3 – 4 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	7 ml
		Lambda Select	A, G, C, L, R, S	6 ml

INSECT, MITE & OTHER RELATED PEST CONTROL

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	12.8 ml
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.57 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	0.23 – 0.46 fl oz
Billbugs (grub or larva) *Identification:* Billbug grubs are white, legless, with a brown head. Young grub feeding inside grass stems are typically quite small, but mature grubs feeding on crown and roots are about 1 cm (4/10 inch) long. *Damage and symptoms:* Billbug grubs 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 but later enlarges into small patch, which turn from yellow to brown. Straw-colored dead grasses are easily pulled out because the hollowed stems are broken from the crowns. Fine, sawdust-like frass can be seen at the base of the broken stems. The affected turf, which appears drought-stressed, does not recover with increased irrigation. Damage usually shows up in mid- to late-summer during extended periods of drought and heat. Infested turf remains firm, not spongy underfoot as with white grub or mole cricket infestations. *Life cycle and monitoring:* There are likely two overlapping generations in the Carolinas, with grubs of various sizes found in the soil and turf. Overwintering grubs are typically more mature and larger. Adults deposit eggs in holes and chew on the stems. After hatching, the grubs bore into the stems and hollow out the stems (creating the sawdust frass). Older grubs feed in the crown and migrate into the soil to pupate. Grubs' damage can be monitored or confirmed by first tugging on dead grass. Those damaged by billbug grubs will break clean from the roots, and sawdust often pour out from the stems. Grubs in the crown and soil can be sampled by extracting and examining soil near damaged turf. *Treatment threshold and management:* There is no verified treatment threshold established for billbug grubs attacking warm- and cool-season turfgrass. Begin preventive treatment against larvae soon after adults become active in the spring. Larger grubs in the crown and soil can also be controlled curatively (although less effectively) in early summer. Insecticides containing neonicotinoids (IRAC 4A) and diamides (IRAC 28) appear to be the most effective options. Insecticides should be watered-in soon after application.	azadirachtin (UN)	AzaGuard	A, C, G, L, R, S	8 – 21 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	6 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	3 lb
		8% Granular Insecticide with Carbaryl	L, R	2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.18 – 0.46 fl oz
		Acelepryn G	A, C, G, L, R, S	1.15 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	1.8 – 2.3 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.14 – 0.29 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.184 – 0.367 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
		Zylam 20SG	A, C, G, L, R, S	1 oz
	dinotefuran + alpha-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	imidacloprid (4A)	Bandit 0.5 G, Malice 75 WSP, Mallet 0.5 G, Merit 0.5 G	A, C, G, L, R	1.4 – 1.8 lb
		Mallet 7.1% PF	A, C, G, L, R, S	1.38 – 1.8 fl oz
		Midash 2SC, Merit 2F, Mallet 2F, etc.	A, C, G, L, R, S	0.46 – 0.6 fl oz
		ImidaGold 70DF, Merit 75 WP, etc.	A, C, G, L, R, S	3 – 4 tsp / 0.15 – 0.2 oz
		Bandit 0.5 G, Mallet 0.5 G, Merit 75 WSP	A, C, G, L, R, S	0.09 – 0.12 packet,

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
				1.4 – 1.8 lb
	imidacloprid + λ-cyhalothrin (4A + 3A)	Imi+Lambda G	A, L, R	3.4 – 4.6 lb
	novaluron (15)	Suprado	A, C, G, L, R, S	2.2 – 3 fl oz
	Steinernema carpocapsae (UC)	NEMAforce SC	A, C, G, L, R, S	25 million units
	tetraniliprole (28)	Tetrino	A, G, L	0.367 – 0.735 fl oz
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	3 lb
		Dylox 420 SL	G, L, R	6.9 fl oz
	cypermethrin + bifenthrin + imidacloprid	Triple Crown Golf	A, C, G, L, R, S	0.57 – 0.80 fl oz
Caterpillars (armyworms, sod webworms, cutworms, skippers, etc.) Fall armyworm, cutworm and sod webworm are the major pest caterpillar species of turfgrass. Other species, such as fiery skipper, are rarely reported as a pest in the Carolinas. Identification of moths (adults) is difficult; therefore, identification is mainly based on the appearance of caterpillars (larvae). For all caterpillar species, the insecticide-treated areas should not be irrigated within 24 hours of treatment so that the caterpillars will come in contact with the residues. ***Fall armyworm*** *Identification:* Fall armyworm is less than 2 mm (8/100 inch) when hatch but can grow to more than 1 inch (25 mm) when mature. The body color of fall armyworm can range from green to black; therefore, body color is not a good characteristic for identification. Fall armyworm can be distinguished from other caterpillar pests by having an inverted Y-shaped white line on its "face." *Damage and symptoms:* Fall armyworm feeds on leaves, with smaller caterpillar skeletonizes and creates "windows" on the leaves, and older caterpillar consumes the entire leaves. Fall armyworms often feed in groups, eventually thinning a large turf area. Although the damage by the fall armyworm is not permanent (i.e. the turf eventually recovers from the damage once fall armyworms have been removed), their damage can become objectionable and recovery from damage may take time. Fall armyworm adults often lay their hair-covered egg masses (each egg mass contains 60-100 eggs) on erected objects such as tree line, walls, and fence posts; as a result, infestation can often be found first near these objects.	acephate (1B)	Livid 90 WDG Prill	G	0.4 – 1.6 oz
		Orthene Turf, Tree, Ornamental WSP	G, S	0.5 – 1.3 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.4 – 0.9 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.9 – 1.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	0.8 – 1.8 oz
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 21 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Bacillus thuringiensis subsp. *aizawai*	Xentari	S (also A, C, G, L, R?)	0.18 – 0.73 oz
	Bacillus thuringiensis subsp. *kurstaski*	BioBit, Crymax, Deliver, Dipel Pro, Javalin WG		
		Bioprotec Plus, Bt Now, Leprotec	L	0.55 – 1.1 fl oz
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.135 – 0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	5 – 10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	1.15 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
Life cycle and monitoring: All fall armyworm die after the first deep frost. Populations persist in the southernmost portions of Florida and Texas, from where the populations grow and migrate northward in the spring. In the Carolinas, the first moth appears in May, but the worst infestation does not appear until August because the population has to build up over time. There are 4 to 5 generations per year in the Carolinas. Fall armyworm can be monitored with soapy solution flush or visual inspection of thinned turf. Repeated congregations of birds and paper wasps on a patch of turf may also indicate potential infestation. These areas should be examined or flushed to confirm infestation. *Treatment threshold and management:* No treatment threshold has been established for golf turf, but a threshold of 1 caterpillar per sq ft had been suggested for lawns. Management begins whenever they are found. While most insecticides are effective, the diamide insecticides (IRAC 28) appear to have the greatest efficacy and residual longevity. ***Cutworms*** *Identification:* Multiple cutworm species are pests of turfgrass, but black cutworm is the most common species in the Carolinas. Black cutworm is grayish green, with two rows of black spots on the back. It often curls into a ball when disturbed or picked up. It can grow to about 4 cm (1.6 inch) when mature. *Damage and symptoms:* Black cutworms seem to prefer short-mown grass and often utilize aerification holes as burrows, which make them frequent pests on greens and tees. They emerge from the burrows at night to feed, which in turn create circular spots of thinned or dead grass and sunken areas around the burrows. This kind of damage can reduce the smoothness and play of the surface. *Life cycle and monitoring:* Black cutworm has 5 to 6 generations and can be found throughout the year in the Carolinas. Cutworm population can be monitored with soapy solution flush or observing for consistent foraging activity of birds and other predators. *Treatment threshold and management:* There is no treatment threshold for black cutworm; a population is managed whenever caterpillars are found. Clipping should be collected from the infested greens and tees and disposed far away so that caterpillars hatched from eggs deposited on the leaves will not return to the turf. Cutworms can be effectively controlled with insecticides. The efficacy of insecticide program can be improved by targeting young caterpillars (thus it is important to conduct monitoring) and by applying the insecticides in late evening to ensure contact of the night-feeding caterpillars with the insecticide residue. ***Sod webworms*** *Identification:* Temperate sod webworm appears throughout the Carolinas, but tropical sod webworm is more common along the coastal counties. Caterpillars		Bifenthrin GC Granules	A, G, L, R, S	1.15 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.18 – 0.25 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 fl oz
		Capture LFR, Sniper LFR	S	0.066 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.05 – 0.08 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.05 – 0.08 fl oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	4 – 8 tbsp
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.05 – 0.09 fl oz
		Acelepryn G	A, C, G, L, R, S	1.15 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	1.0 – 4.6 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 6 fl oz
		Carbaryl 5% Dust	L	Light dust
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 lb
	chlorpyrifos (1B)	Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 lb /acre
	Chromobacterium subtsugae (UNB)	Grandevo PTO	A, C, G, L, R, S	0.75 – 1.5 oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	2.7 – 3.7 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.22 – 0.29 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.046 – 0.367 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
of both species look similar: they are greenish to light brown, with dark brown heads and many dark spots on the back. Adults of the two species appear different, however, with the temperate sod webworm moth rolls up its grayish wings (shaped like a cigar), and the tropical sod webworm both lay its brownish wings flat in a triangle. Caterpillars of the two species behave differently: temperature sod webworm rolls into a ball when disturbed, but tropical sod webworm will thrash about or move rapidly. *Damage and symptoms:* Feeding can thin short-mown turf or create a ragged appearance on tall grass. The caterpillars often feed and create a trail of thinned grass on short-mown grass on greens and tees. *Life cycle and monitoring:* Three or four generations are possible from late spring through fall in the Carolinas, but sod webworms have been found throughout the year in some coastal counties. Damage is most noticeable in late summer when grass growth has slowed down and could not compensate for damage. Both species feed at night and hide in the thatch layer during the day. Caterpillars can be found in the thatch by parting the grass, or by conducting soapy solution flush. *Treatment threshold and management:* Treatment thresholds are 20 to 30 caterpillars per sq yard in high-cut turf, and 5 to 15 caterpillars in golf greens and tees. Endophyte-enriched grasses can be overseeded to help with caterpillar management in fall and winter. Most insecticides are effective against sod webworms. The keys to successful management are to target younger caterpillars and make application in late evening.		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	diflubenzuron (15)	Cavalier 2L, Dimilin 2L, Durant 2L	S	0.046 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + α-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	imidacloprid + λ-cyhalothrin (4A + 3A)	Imi+Lambda G	A, L, R	3.4 – 4.6 lb
	indoxacarb (22A)	Provaunt WDG	A, C, G, L, R	0.07 – 0.14 oz
		Provaunt	A, C, G, L, R	0.046 – 0.092 oz
	iron phosphate + spinosad (NC + 5)	Antixx Plus	A, C, G, L, R	0.23 – 1 lb
		Sluggo Plus	L	0.5 – 1 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	methomyl (1A)	Lannate LV, Annihilate LV, etc.	S	1.1 fl oz
		Lannate SP, Annihilate SP, etc.	S	0.4 oz
	mineral oil (UC)	Civitas Turf Defense	A, G	8.5 – 17 fl oz
	novaluron (15)	Suprado	A, C, G, L, R, S	0.75 – 1.5 fl oz
	spinosad (5)	Conserve SC	A, C, G, L, R, S	0.25 – 1.2 fl oz
	Steinernema carpocapsae (UC)	NEMAforce SC	A, C, G, L, R, S	25 million units
	tetraniliprole (28)	Tetrino	A, G, L	0.367 – 0.735 fl oz
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	2 – 3 lb
		Dylox 420 SL	G, L, R	4.6 – 6.9 fl oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin +	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.34 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	imidacloprid (3A + 3A + 4A)	Triple Crown T&O	A, C, L, R	
Chiggers and Ticks Chiggers (red bugs) and ticks may be present in turfgrass areas. Although they don't damage turf, they can become medical risks to humans and pets. ***Chigger*** Larvae of the chigger mite are common on grass and other vegetations next to woodlots and other damp areas. Contrary to common beliefs, larval chigger mites do not suck on blood but instead feeding on the content of skin cells. After boring into the skin, they chew up inner skin cells and inject digestive enzymes, which cause swelling and irritation. They emerge from the skin and drop to the ground to pupate and become adult. Itch occurs after the larvae have left, so any notion that a remedy can "kill" the chigger in the skin is incorrect. ***Ticks*** Several tick species occur in the Carolinas, with American dog tick, brown dog tick, lone star tick and black-legged (or deer) tick being the most common species. Ticks occurring in lawns are associated with animals (pets and wildlife) active in the same lawns. Ticks and tick eggs are often found in crevices and leaf litter. Hungry ticks will move to tall grass and attach to animals (including humans) passing by. Insecticide treatments are often ineffective when applied infrequently. Knowing that chiggers and ticks prefer and utilize tall grass as habitat and perch and keeping grass mowed short can help remove habitats that are advantageous to chiggers and ticks. Persons sensitive to their "bites" or those who live in areas with a large number of chiggers and ticks should avoid contact and infestation by applying repellents (such as DEET) and wearing protective clothing.	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	Azatrol EC, AzaGuard	A, C, G, L, R, S	1.3 – 21 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.135 – 0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	5 – 10 grams
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	0.75 – 3 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	0.35 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.5 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.5 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16 – 0.32 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.16 – 0.32 fl oz
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.25 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
	clothianidin + bifenthrin (4A+ 3A)	Aloft LC G	A, C, L, R	1.8 – 3.2 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		Suspend SC	L	0.25 – 1.5 fl oz
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	fipronil (2B)	Fipronil 0.0143G, TopChoice	A, C, G, L, R, S	2 lb (broadcast)
		Chipco Choice, Fipronil 0.1G	A, C, G, L, R, S	4.6 oz (broadcast)

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	fipronil + bifenthrin + λ-cyhalothrin (2A + 3A + 3A)	Taurus Trio G	A, C, G, L, R, S	2 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	Metarhizium brunneum (UBF)	LALGUARD M52 GR	A, G, L, R, S	1 – 3 lb
	pyriproxyfen (7C)	Archer IGR	L	0.67 fl oz
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.2 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.46 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	
Chinch Bugs (southern chinch bug) *Identification:* Although several chinch bug species occur in the US, southern chinch bug is the most common species in the Carolinas. St. Augustine grass is the turf species most commonly damaged. Southern chinch bugs are small, with adults about 4 mm (15/100 inch) long and young nymphs about 1 mm (4/100 inch) long. Wings of adults are folded flat over the bodies and appear white with distinctive triangular black markings in the middle. A typical adult population in the Carolinas often consists of both short- and long-winged forms. Young nymphs are red and become increasingly black as they develop. Nymphs do not have wings, but with a white line across the middle of the back. *Damage and symptoms:* Southern chinch bugs feed in large numbers in the thatch. They use piercing-sucking mouthpart to extract nutrients from the plants. Feeding by chinch bugs stresses grass, and nutrient removal weakens the grass over time. Infested turf first appears yellow and stunted. As the infestation progresses, the grass wilts and dies, creating small dead patches. The dead patches expand as infestation continues and damage worsens. A complete loss of turf is often reported when management is not applied on time. Hot, dry weather, deep thatch, and high fertility favor chinch bug development. *Life cycle and monitoring:* Southern chinch bug develops through five instars,	acephate (1B)	Livid 90 WDG Prill	G	1 – 1.6 oz
		Orthene Turf, Tree, Ornamental WSP	G, S	1.2 – 2 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.9 – 1.5 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.9 – 1.4 oz
	acephate + imidacloprid (1B +4A)	Avatar PLX	G, S	1.8 – 2.94 oz
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 21 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (FRAC 11 + IRAC 4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
		Bioceres	G, L, R	1.1 – 2.2 oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
and a generation is typically completed in one month. Five to 6 generations are possible each year along the coast, whereas 3 to 4 generations are possible inland. Chinch bugs of all life stages can be found in turf throughout the year, but population begins to increase in late spring. The worst damage typically occurs in August, but hot, dry weather can worsen damage and make it appear early. Infestation is typically indicated by chlorotic grass and confirmed with the flotation or vacuum sampling method. To conduct floatation sampling, an open-ended cylinder (metal can or PVC pipe) driven several inches into the soil can be filled with clean tap water (note: NOT soapy water). Alternatively, plugs of turf and soil taken from damaged turf can be placed in a 5-gallon bucket filled with clean water. In both methods, adults and nymphs will float to the water surface within 1 minute. The cylinder should be inserted, or the plugs collected from turf area showing signs of declining or discoloration, not from dead turf.		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.5 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16 – 0.32 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.16 – 0.32 fl oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	4 – 8 tbsp
Treatment threshold and management: Treatment threshold of 25 to 30 insects per square foot had been suggested, but many turf managers typically make application before chinch bug density reaches the threshold. Often, management is on a calendar basis and treatments are applied in late spring or early summer before damage appears. Pyrethroids (IRAC 3A) have been the main tool of management. But repeated applications have led to the development of insecticide resistance among several populations in Florida and Texas. Although resistant populations have not been confirmed in the Carolinas, it is prudent for all turf producers and managers to rotate among insecticides of different modes of action (or IRAC numbers).	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	4.4 – 6 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.18 – 0.46 fl oz
		Acelepryn G	A, C, G, L, R, S	1.15 – 2.3 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
Chinch bugs are often found in the thatch layer. Thus, higher application volume is critical in delivering the insecticides through the thatch layer. In general, use a minimum spray volume of 50 gallons/acre (1.2 gallons/1000 sq ft); the higher the spray volume, the better. When a granular insecticide is used, the insecticides should be pushed into the thatch layer by irrigating after the treatment.	chlorpyrifos (1B)	Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 Ib/acre
St. Augustinegrass varieties ‘Floratam’, ‘Floralawn’ and ‘Captiva’ are resistant to chinch bugs. These resistant varieties, however, may not be readily available from local sod producers.	*Chromobacterium subtsugae* (UNB)	Grandevo PTO	A, C, G, L, R, S	0.75 – 1.5 oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	2.7 – 3.7 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.22 – 0.29 oz
How St. Augustinegrass turf is managed can have significant influence on chinch bug abundance and damage. The greatest damage is often found on turf that is grown under full sun, drought stressed, heavily fertilized, mown high, and has thick thatch. Therefore, cultural control tactics that can remediate or reverse the above conditions should be practiced. When installing sods, St. Augustine grass should be grown in partially shaded areas instead of under full sun. Those grown under full sun should receive additional irrigation to avoid heat and drought stress. The lawn should be fertilized at the appropriate rate (determined by soil test) and mowed at the appropriate height (2-3" in sunny areas and 3-4" in shaded areas). Dethatching should be conducted periodically.	clothianidin+ bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz)
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.184 – 0.459 fl oz

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	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + alpha-cypermethrin (4 + 3)	Alucion 35 WG	G, L, R	0.44 oz
	imidacloprid (4A)	Bandit 0.5 G, Malice 75 WSP, Mallet 0.5 G, Merit 0.5 G	A, C, G, L, R	1.8 lb
		Mallet 7.1% PF	A, C, G, L, R, S	1.8 fl oz
		Midash 2SC, Merit 2F, Mallet 2F, etc.	A, C, G, L, R, S	0.6 fl oz
		ImidaGold 70DF, Merit 75 WP, etc.	A, C, G, L, R, S	4 tsp or 0.2 oz
		Bandit 0.5 G, Mallet 0.5 G, Merit 75 WSP	A, C, G, L, R, S	0.12 packet, 1.8 lb
	imidacloprid + λ-cyhalothrin (4A + 3A)	Imi+Lambda G	A, L, R	3.4 – 4.6 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	3 – 4 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	7 ml
		Lambda GC-O	A, C, G, L, R, S	14 ml
		Lambda Select	A, G, C, L, R, S	12 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	novaluron (15)	Suprado	A, C, G, L, R, S	2.2 – 3 fl oz
	Steinernema carpocapsae (UC)	NEMAforce SC	A, C, G, L, R, S	25 million units
	tetraniliprole (28)	Tetrino	A, G, L	0.367 – 0.735 fl oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	3 lb
		Dylox 420 SL	G, L, R	6.9 fl oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.46 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	
Clover Mite (also bank grass mite, winter grain, & other mites) Several non-eriophyid mite species are active in turfgrass. Clover mite is the most commonly reported species. *Identification:* Adult clover mite is about 1 mm (4/100 inch) long, reddish	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard	A, C, G, L, R, S	10 – 16 fl oz
	bifenthrin (3A)	Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur	A, C, G, L, R, S	0.08 – 0.16 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
brown, and with four pairs of legs (with the front pair the longest). *Damage and symptoms:* Clover mites are most commonly found along the foundation of houses and in sunny, dry areas of lawns. They feed on broadleaf plants and turfgrass, but the damage they cause (chlorosis of leaves) is typically minor. They become a nuisance pest when a large number of bright red mites invade homes in the spring and fall. *Life cycle and monitoring*: Clover mites are active in the cooler spring, fall and winter. They survive the hot summer in egg stage. Dry weather typically favors population build-up. The mites can be found on various broadleaf and grassy plant species near the foundation of houses, particularly on the south and west sides. They can be easily seen, even without a magnifying lens. *Treatment threshold and management:* No treatment threshold has been established. A homeowner often finds the population needing reduction when the mites invade a home. Treatment in the house should be performed by a licensed pest control operator. Most insecticides are effective in reducing mite population in the lawn. Irrigation in the spring may help to reduce the population.		X, etc.		
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	chlorpyrifos (1B)	Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Dursban 50W	S	2 lb/acre
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		Suspend SC	L	0.25 – 1.5 fl oz
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	hexythiazox (10A)	Hexygon DF, Hexcel 50 DF	A, C, G, L, R, S	0.07 – 0.14 oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	mineral oil (UC)	Civitas Turf Defense	A, G	8.5 – 17 fl oz
	spiromesifen (23)	Forbid 4F	A, C, G, L, R	1.4 – 4 fl oz/100 gal
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Earthworms (worm casting) Earthworms are beneficial organisms, and no pesticide is labeled for their management. Worm casting, i.e., waste created by the earthworms, can interfere with play on golf courses. Liming, soil acidification, clipping removal, and topdressing with angular sand produced inconsistent results. Products containing saponin, such as early Bird 3-0-1, had been shown to provide the best reduction in worm casting. However, the manufacturer of Early Bird 3-0-1 terminated the production of the organic fertilizer. Stink worms or crazy worms appear less sensitive to saponin when compared to the European species.	**No pesticide is registered.**			
Fleas	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	

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Two flea species are most commonly encountered in turf: the cat flea and the dog flea. The species are associated with pets, and infestations are often found near areas where the animals rest or nest. Adult fleas are small (2.5 mm or 1/10 inch), brown, wingless, and with long, strong hind legs modified for jumping. Only adult bites. Flea larvae feed on decaying organic debris, wastes, and feces. Flea bites can cause severe irritations in humans and pets. Most insecticides are applied when need arises, and are usually quite effective against adults. The insecticides, however, are not particularly effective against larvae and pupae (which hide in the soil or debris); so, repeated applications are often needed as adult fleas continue to be produced from the larval population.		Tempo Ultra WP, WSP	A, C, L, R	10 grams
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.5 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Capture LFR, Sniper LFR	S	0.2 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.08 – 0.32 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	6 fl oz
		Sevin 7G	A, C, G, L, R, S	3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	Duocide	A, L, R	4 – 8 lb
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
	deltamethrin (3A)	Suspend SC	L	0.25 – 1.5 fl oz
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	fipronil (2B)	Fipronil 0.0143G, TopChoice	A, C, G, L, R, S	2 lb (broadcast)
		Chipco Choice, Fipronil 0.1G	A, C, G, L, R, S	4.6 oz (broadcast)
	fipronil + bifenthrin + λ-cyhalothrin	Taurus Trio G	A, C, G, L, R, S	2 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	pyriproxyfen (7C)	Archer IGR	L	0.67 fl oz
	spinosad (5)	Conserve SC	A, C, G, L, R, S	1.2 fl oz
	Steinernema carpocapsae (UC)	NEMAforce SC	A, C, G, L, R, S	25 million units
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.8 fl oz
		Triple Crown T&O	A, C, L, R	
Grasshoppers and/or Crickets Grasshoppers and crickets are minor pests of turf. They feed on various plant species and rarely damage turf. Often, grasshoppers are treated because they are objectionable to turf users or managers, and crickets are managed because they invade homes occasionally. Most grasshoppers and crickets on turf originate from elsewhere, so management goal is to reduce the numbers that are present in the general area instead of just the turf. Most insecticides are effective in reducing their numbers. Because they are minor and transient pests, management may not even be needed.	acephate (1B)	Orthene Turf, Tree, Ornamental WSP	G, S	0.5 oz
		Livid 90 WDG Prill	G	0.1 – 0.4 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.4 – 0.9 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	0.8 oz
	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	Azatrol EC	A, C, G, L, R, S	1.3 fl oz
		AzaGuard	A, C, G, L, R, S	10 – 16 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.135 – 0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	5 – 10 grams
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb (broadcast)
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Capture LFR, Sniper LFR	S	0.1 – 0.4 fl oz
	bifenthrin (3A)	Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.08 – 0.16 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		SA-50 Mole Cricket Bait	L	0.75 – 0.9 lb
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	chlorpyrifos (1B)	Chlorpyrifos 1% Mole Cricket Bait	G, S	2.5 lb
		Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 – 4 lb/acre
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		Suspend SC	L	0.25 – 1.5 fl oz
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	hydramethylnon (20A)	Maxforce Complete Granular Bait	A, C, G, L, R	0.56 oz
	indoxacarb (22A)	Advion Insect Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
		Provaunt WDG	A, C, G, L, R	0.41 oz
		Provaunt	A, C, G, L, R	0.275 oz
	indoxacarb + novaluron (22A + 15)	Doxem IG Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
	iron phosphate + spinosad (NC + 5)	Antixx Plus	A, C, G, L, R	0.23 – 1 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
	lambda-cyhalothrin (3A)	Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.2 – 0.6 fl oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.06 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Ground Pearls Ground pearl is a scale insect. It is the most serious pest of centipedegrass lawns	**No pesticide is registered. No effective pesticide has been identified.**			

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
in sandy soil, although it can also feed on many turfgrass and grassy weed species. Nymphs are enveloped in pearly waxy cysts in the soil (thus its common name), which makes them impossible to control. Adult females emerge from the cysts as soft-bodied, slow-moving, pink insects with very little wax on the body. Although adults are the targets for management, insecticide applications during adult emergence (usually in June or July) have not been successful. They use their piercing-sucking mouthpart to extract sap and nutrients from the roots, slowly weakening and killing the turfgrass.				
Leafhoppers and/or Planthoppers Leafhoppers and planthoppers are common occurrences in turf, however, reports of extensive damage are rare. Their appearance in turf is commonly associated with vegetations around the turf. The population builds up on these vegetations, then individuals move into the turf. Several leafhopper and planthopper species occur in turfgrass, but there is a poor understanding of which species could be damaging to turf. The St. Augustine grass planthopper, *Syndelphax pseudoseminigra*, had been identified as an occasional pest on St. Augustine grass lawns in coastal SC. Leafhoppers and planthoppers feed by sucking sap and nutrients from grasses, which results in chlorosis, bleaching and drying out of turf. Turf death due to leafhopper or planthopper infestation has not been reported. The appearance of a large number of leafhoppers and planthoppers can be objectionable to turf managers or users and becomes the major reason for management. Leafhoppers and planthoppers are typically small (about 4 to 7 mm or 16/100 to 28/100 inch). Nymphs are wingless and monochromatic, but adults are winged and colorful with light yellow or green bodies marked by other dark colored lines or patches. All life stages are capable of jumping/hopping; thus, their common names. Because they rarely damage turf, management is often not necessary. Maintaining appropriate amount and frequency of irrigation can help maintain turf health and vigor and withstand leafhopper and planthopper feeding. Most insecticides can be effective when management is needed to reduce turf discoloration or insect abundance. Since insects may continue to invade the treated turf from nearby vegetations, repeated applications may be needed.	acephate (1B)	Livid 90 WDG Prill	G	0.8 oz
		Orthene Turf, Tree, Ornamental WSP	G, S	1 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.4 – 0.9 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.75 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	1.6 oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 21 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	4 – 8 tbsp
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	1.15 – 2.3 lb
		Bifenthrin GC Granules	A, G, L, R, S	1.15 – 2.3 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
	carbaryl + bifenthrin (1A + 3A)	Duocide	A, L, R	2 – 4 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	3.4 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 lb/acre
	Chromobacterium subtsugae (UNB)	Grandevo PTO	A, C, G, L, R, S	0.75 – 1.5 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Mealybugs (rhodesgrass mealybug) Rhodesgrass mealybug is the most important mealybug species on turfgrass in the Carolinas. In Florida, other mealybug species, such as tuttle mealybug, is becoming an increasingly damaging pest. Long being a pest of lawns (of many grass species), rhodesgrass mealybug is becoming an increasingly problematic pest on bermudagrass greens. All life stages feed on grass nodes, but only the adult females are visible, appearing as white, fuzzy rice grains protruding from the nodes. Strands of long, white, curly filaments protrude from the rear end of the adults. Rhodesgrass mealybug removes sap and nutrients from the grass, causing chlorosis and stunted growth, and eventually death. Damaged greens appear chlorotic, with irregular patches of discolored, declining turf that resemble drought stress or nematode infestation (but do not respond to irrigation or treatment). Rhodesgrass mealybug secretes honeydew, which attracts bees and wasps (these can become nuisances or medical concerns) and promotes sooty	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	10 – 16 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb (broadcast)
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	1.15 – 2.3 lb
		Bifenthrin GC Granules	A, G, L, R, S	1.15 – 2.3 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
mold growth. Rhodesgrass mealybug can be found by parting the grass and look for the fuzzy rice grains and associated sooty mold, which stains the underlying sand and thatch black. No treatment threshold has been established, and no insecticide has been registered specifically against rhodesgrass mealybug. Insecticides listed in this table are those registered for mealybug management in general. Recent studies in SC and GA suggest that acephate (1A) and neonicotinoids (4A) are the most effective insecticides. Insecticides should be applied in August, repeated biweekly or monthly. Multiple yearly treatments may be needed before infestation is completely controlled.		Capture LFR, Sniper LFR	S	0.1 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.08 – 0.16 fl oz
		Baseline, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
		Bifenture EC, Brigade 2EC	S	0.08 – 0.16 fl oz
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	mineral oil (UC)	Civitas Turf Defense	A, G	8.5 – 17 fl oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.06 – 0.09 fl oz
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Millipedes and/or Centipedes Millipedes and centipedes do not feed on turfgrass but their appearance in turf and their invasion of homes may be objectionable. The major reason for their management is to reduce the numbers that invade homes. A perimeter treatment by a pest control operator is sufficient to prevent home invasion by a light infestation. In heavy infestation, however, treatment of lawns and landscapes may be needed to reduce the overall numbers of invaders. ***Millipedes*** Millipedes feed on decaying organic matters in damp lawns and landscapes. Several species are common in the Carolinas, and most of them are within 1 inch also curl up into a ball when disturbed or touched. ***Centipedes*** Centipedes are predators. Similar to millipedes, they also prefer to live in damp lawns and landscapes. They hide under logs, flowerpots and other secluded places during the day and emerge at night to hunt. Most centipede species in the Carolinas are small, and do not pose serious medical problems for human and pets. Although insecticides are often effective against millipedes and centipedes, a	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	4.8 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
	bifenthrin (3A)	Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 0.5 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
		Dursban 50W	S	2 lb/acre
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
long-term management approach should involve modifying the lawns and landscapes so that they are less suitable habitats for millipedes and centipedes. These would include pruning overgrown landscape plants and trees, removing old, decaying and excessive mulch, clearing areas of hiding places such as unused pots and trash, etc.	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		Suspend SC	L	0.25 – 1.5 fl oz
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	indoxacarb (22A)	Advion Insect Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.06 – 0.1 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Mole Crickets Mole crickets are perennial pest problems for all turf sites in much of SC and eastern NC. Mole cricket infestation and damage have not been severe historically in the in-land regions, but as tawny and southern mole crickets expand their distribution, reports of damage have become increasingly common. *Identification:* Several mole crickets species are associated with turfgrass, but only tawny mole cricket and southern mole cricket are considered serious pests. Both species are invasive species introduced accidentally from South America. The native northern mole cricket is an occasional pest that is typically associated with swampy or wet habitats, or bodies of water. Similar to all mole cricket species, tawny mole cricket has a pair of front legs modified for digging. The tibial dactyls (think of them like fingers on a human hand) form a V-shaped gap. The pronotum (section right behind the head) of nymphs and adults has a mottle brown pattern on the top. Nymphs are wingless, but the wing buds become increasingly longer with each successive instar. Adults have a pair of fully developed wings and are about 3.3 cm (1.3 inch) long. Tawny mole crickets feed only on plants, including turfgrass. Southern mole cricket is about the same size as tawny mole cricket, but their tibial dactyls form a U-shaped gap. They have four pale white spots on the pronotum. Southern mole crickets distribute more widely and more towards in-	acephate (1B)	Orthene Turf, Tree, Ornamental WSP	G, S	1 – 2 oz
		Livid 90 WDG Prill	G	0.8 – 1.6 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.8 – 1.4 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.8 – 1.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	1.6 – 2.8 oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	10 – 16 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	2.4 – 4.8 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	2.3 – 4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	2.3 – 4.6 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
land regions than tawny mole crickets. They have a more varied diet that includes plants, earthworms and other insects. *Damage and symptoms:* The damage by mole crickets to turf is associated mainly with their digging activities. Tunneling activities are more severe on sandy soil and short-mown turf. Not only are the tunnels they create aesthetically unacceptable (especially on short-mown or high-value areas, such as greens and tees), but the tunnels can also expose roots to desiccation (particularly damaging to newly sprigged or seeded areas) and interfere with mowing and play. *Life cycle and monitoring:* Both tawny and southern mole crickets have one generation per year. Each generation overwinters as adults or large nymphs. When night temperature in early spring is consistently above 65°F, mole crickets may move and create tunnels, sometimes as early as February. But these early-spring activities usually subside when the temperature drops again. Consistent flight and tunneling activities begin in April and continue as adults mate and reproduce (mainly in May through June) until July. Eggs hatch in May through July, and nymphs develop through the rest of the year, with the first adults appearing in late September. Tunneling damage is most severe by adult mole crickets in April through June, and by large nymphs and adults in September through November. Infested areas can be easily identified by the tunnels. Soapy solution flush is very important for collecting and identifying life stages of the mole crickets. Treatment should be timed based on soapy solution flush results to target young nymphs. Older nymphs and adults are more difficult to control (thus a more effective product and a high application rate may have to be used) and better at avoiding treated areas (thus reducing contact with insecticide residue, especially when using fipronil). *Treatment threshold and management:* No treatment threshold has been established. Treatment in the early spring to reduce tunneling activities and the numbers of adult mole crickets that will lay eggs in late spring may be necessary in some cases. The most effective treatment, however, is conducted in late May or early June to target young nymphs. Fipronil is very effective against mole crickets, but because of its cost and other use restrictions, most turf managers often apply fipronil as spot or small-area treatment for the most infested or high-value areas, such as greens and tees. A commonly used program is to apply acephate or a pyrethroid in early spring to suppress adult tunneling activity in the spring, followed by applications of a combination of a pyrethroid and a neonicotinoid, or indoxacarb, against nymphs in the summer, and then an application of acephate or a pyrethroid against large nymphs and adults in the fall (if necessary). After treatment, irrigate sprays or granules (except for baits) into the soil to improve contact of the mole crickets with the insecticide residue.		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.5 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 1 fl oz
		Capture LFR, Sniper LFR	S	0.2 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16 – 0.32 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.16 – 0.32 fl oz
	carbaryl (1A)	SA-50 Mole Cricket Bait	L	0.75 – 0.9 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	3.4 – 4.6 fl oz
	chlorpyrifos (1B)	Chlorpyrifos 1% Mole Cricket Bait	G, S	2.5 lb
		Chlorpyrifos SPC 2, SPC 4	G	1.5 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	1.5 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	1.5 fl oz
		Dursban 50W	S	4 – 6 Ib/acre
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	2.7 – 3.7 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.29 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	dinotefuran	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + alpha-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	fipronil (2B)	Fipronil 0.0143G, TopChoice	A, C, G, L, R, S	2 lb (broadcast)
		Chipco Choice, Fipronil 0.1G	A, C, G, L, R, S	4.6 – 9.4 oz (slit)
	fipronil + bifenthrin + lambda-cyhalothrin (2B + 3A + 3A)	Taurus Trio G, Lesco Trivium G	A, C, G, L, R, S	2 lb (broadcast)
	imidacloprid (4A)	Bandit 0.5 G, Malice 75 WSP, Mallet 0.5 G, Merit 0.5 G	A, C, G, L, R	1.8 lb
		Mallet 7.1% PF	A, C, G, L, R, S	1.8 fl oz
		Midash 2SC, Merit 2F, Mallet 2F, etc.	A, C, G, L, R, S	0.6 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
Applying pesticides late in the day or irrigating before application can also improve contact of mole cricket with insecticides. Do not irrigate after applying baits for at least a day. Use a higher application rate for large nymphs and adult mole cricket control.		ImidaGold 70DF, Merit 75 WP, etc.	A, C, G, L, R, S	4 tsp or 0.2 oz
		Bandit 0.5 G, Mallet 0.5 G, Merit 75 WSP	A, C, G, L, R, S	0.12 packet, 1.8 lb
	imidacloprid + λ-cyhalothrin (4A + 3A)	Imi+Lambda G	A, L, R	3.4 – 4.6 lb
	indoxacarb (22A)	Advion Insect Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
		Provaunt	A, C, G, L, R	0.275 oz
		Provaunt WDG	A, C, G, L, R	0.41 oz
	indoxacarb + novaluron (22A + 15)	Doxem IG Granular Bait	A, C, G, L, R	1.15 – 4.6 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	3 – 4 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	7 ml
		Scimitar GC	A, C, G, L, R, S	7 ml
		Lambda GC-O	A, C, G, L, R, S	7 – 14 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	12.8 ml
	thiamethoxam (4A)	Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	3 lb
		Dylox 420 SL	G, L, R	6.9 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.46 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	
Pillbugs and/or Sowbugs Pillbugs and sowbugs do not feed on turfgrass; instead, they feed on decaying organic matters and succulent plant tissues. They are managed often because of their tendency to invade homes. A perimeter treatment by a pest control operator and sealing off entries to the houses are sufficient in preventing home invasion. Management of the population in the lawns may be necessary in some cases. Contrary to popular understanding, pillbugs and sowbugs are not the same creatures. Adult of both groups are about 5 to 10 mm (2/100 to 4/100 inch) in length, slightly flattened, segmented, and gray to black in color. Pillbugs can roll	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	bifenthrin (3A)	Bifenthrin 0.1% Granular	L	1.2 – 2.4 lb
		Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	4.6 lb
		Bifenthrin GC Granules	A, G, L, R, S	4.6 lb
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
into a ball when disturbed, but sowbugs cannot. Insecticides can be effective management tools, but they are often short lasting. Environmental modifications may be more feasible for long-term management of pillbug or sowbug infestation. Since both species prefer damp, shaded habitats and utilize debris and other objects for hiding places, pruning, proper mowing, and cleaning up old mulch, debris and trash can help reduce suitable habitats and refuges for the pillbugs and sowbugs and reduce their populations over time.	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	8 lb
	chlorpyrifos (1B)	Chlorpyrifos 1% Mole Cricket Bait	G, S	2.5 lb
		Chlorpyrifos 2.5% Granular	G, S	1 lb
		Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos SPC 4	G	0.75 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	0.75 fl oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	iron phosphate + spinosad (NC + 5)	Antixx Plus	A, C, G, L, R	0.23 – 1 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, G, L	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	zeta-cypermethrin + bifenthrin (both 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	2.3 – 4.6 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.46 fl oz
		Triple Crown T&O	A, C, L, R	
Scale insects (bermudagrass scale and other soft and armored scale insects) Bermudagrass scale is a common species in SC but reports of its damage are rare. Scale insects feed and can be treated in similar manner as rhodesgrass mealybug.	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	10 – 16 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
Scarab Beetles (black turfgrass ataenius, chafers, green June beetle, May beetle, June beetle, Japanese beetle, sugarcane beetle adult) Scarab beetles are adults of white grubs. Scarab beetles do not feed on turfgrass,	acephate (1B)	Orthene Turf, Tree, Ornamental WSP	G, S	1.5 – 2 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	1.1 – 1.5 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.9 – 1.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	2.2 – 2.94 oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
but they can damage turf in several ways. They are not desirable in turf because some species (such as Japanese beetles, chafers, May/June beetles, and green June beetles) may enter the soil and lay eggs, which results in white grub infestation. They can also damage the turf and expose roots when they dig into or tunnel in the soil (such as black sugarcane beetle, sugarcane beetle, and carrot beetle). Some species (such as black turfgrass ataenius) appear in large numbers and can become a nuisance to turf managers, golfers, and turf users. Infestations by scarab beetles and white grubs often lead to extensive digging by animals looking for beetles or grubs as food. There is no threshold or reliable monitoring method for scarab beetles. A soapy solution flush or a pyrethroid spray of suspected areas results in the emergence of scarab beetles closer to the turf surface. These flushed scarab beetles can then be collected and identified. Understand that some scarab beetles burrow as deep as 4 inches to lay eggs, so soapy solution flush may not detect these species and cannot serve as an effective management method. There is a poor understanding of the mechanism by which they select turf in which they conduct digging or reproductive activities. The lack of this knowledge limits our ability to develop cultural management practices to avoid infestation by scarab beetles. Limiting nighttime lighting near turf has been suggested as a method of reducing infestation because scarab beetles are active at night and are attracted to light. Scarab beetles are managed with an insecticide whenever a need arises. Many insecticides listed here are labeled for black turfgrass ataenius but could be used against most scarab beetle species. The efficacy of most insecticides is unknown, but likely to be limited.	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	azadirachtin (UC)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 16 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
	beta-cyfluthrin (3A)	Tempo SC Ultra	A, C, L, R	0.27 fl oz
		Tempo Ultra GC	G, A, C, L, R	
		Tempo Ultra WP, WSP	A, C, L, R	5 – 10 grams
	bifenthrin (3A)	Bifen L/P G, Bifenthrin GC, Crosscheck EZ, Lawnstar G, UP-Star Gold G, etc.	A, C, L, R	1.15 – 2.3 lb
		Bifenthrin GC Granules	A, G, L, R, S	1.15 – 2.3 lb
		Bifen 7.9F, UP-Star Gold, Talstar P	A, C, L, R	0.25 – 1 fl oz
		Bifenthrin GC, Wisdom TC, UP-Star SC	A, C, G, L, R, S	0.25 – 0.5 fl oz
		Capture LFR, Sniper LFR	S	0.1 – 0.4 fl oz
		Bifen 2 AG, OnyxPro, Reveal Endur X, etc.	A, C, G, L, R, S	0.16 – 0.32 fl oz
		Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.3 fl oz
		Bifenture EC, Brigade 2EC	S	0.16 – 0.32 fl oz
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	chlorpyrifos (1B)	Chlorpyrifos SPC 2	G	1.5 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	1.5 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	1.5 fl oz
		Dursban 50W	S	4 Ib/acre
	clothianidin + bifenthrin (4A+ 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		D-Fense SC	A, L, R	0.6 – 0.9 fl oz
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb

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		Avesta CS, Demand CS, Scimitar CS	A, C, L, R	3.4 – 7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	3.4 – 7 ml
		Lambda Select	A, G, C, L, R, S	2.9 – 6 ml
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	6.4 – 12.8 ml
	spinosad (5)	Conserve SC	A, C, G, L, R, S	1.2 fl oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	zeta-cypermethrin + bifenthrin (3A + 3A)	Talstar XTRA GC Granular	A, C, G, L, R, S	1.15 – 2.3 lb
		Talstar XTRA Granular	A, C, L, R	
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.23 – 0.80 fl oz
		Triple Crown T&O	A, C, L, R	
Snails and/or Slugs Snails and slugs are managed because of their tendency to invade homes. Although bait is available for management in turf, long-term solutions may rest on removing thatch and debris and making the lawns less damp and shaded to deny them suitable habitats and refuges.	iron phosphate + spinosad (NC + 5)	Antixx Plus, Sluggo	A, C, G, L, R	0.23 – 1 lb
Spittlebugs (two-lined spittlebug) Two-lined spittlebug is the most common spittlebug species in the turf of the Carolinas. Two-lined spittlebug nymphs can be particularly problematic on centipedegrass lawns and sods. Adults have black wings with two orange lines across, and red eyes, legs and abdomen. The red abdomen is particularly noticeable when adults fly (such as when disturbed by mower). Nymphs do not have wings and are light green or yellow in color. They feed on stems and stolons in the thatch layer, and use plant sap to create "spittle," within which the nymphs hide. The spittles created by nymphs make the turf squishy and unpleasant under foot. Feeding by nymphs and adults causes plant chlorosis. Heavy infestation can cause brown patches on turf. There are two generations in SC, with adults most common in June-July and August-September. No threshold has been established. No warm-season turfgrass species appear resistant to two-lined spittlebug. Because it is observed that high mowing height and thatch buildup aggravate the problem, dethatching and withholding irrigation when nymphs are hatching in May and July may help alleviate the infestation. Insecticide treatment is applied when nymphs are present, and damage appears.	acephate (1B)	Orthene Turf, Tree, Ornamental WSP	G, S	1 – 2 oz
		Orthene TTO 97, Acephate 97 WDG	G, S	0.8 – 1.4 oz
	acephate + bifenthrin (1B + 3A)	Acenthrin	G, S	0.8 – 1.4 oz
	acephate + imidacloprid (1B + 4A)	Avatar PLX	G, S	1.6 – 2.8 oz
	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 16 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	bifenthrin (3A)	Baseline, Bifen XTS, UP-Star EC	A, C, L, R	0.07 – 0.15 fl oz
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	2 – 4 lb
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 3 fl oz
		6.3% Sevin Brand Granular Carbaryl	L, R	2.2 – 3 lb
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
		8% Granular Insecticide with Carbaryl	L, R	1.7 – 2.4 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.28 – 0.46 fl oz
	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	3.4 – 4.6 fl oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	1.8 – 2.3 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.14 – 0.29 oz

INSECT, MITE & OTHER RELATED PEST CONTROL

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[3]Use sites: A = athletic or sport fields; C = cemeteries; G = golf courses; L = residential and/or commercial lawns; R = recreational areas and/or parks; S = sod farms. Read label for use sites and restrictions.

Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	1.8 – 3.6 lb
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	2 – 3 lb
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	zeta-cypermethrin (3A)	Mustang, Mustang Maxx	S	0.05 – 0.1 fl oz
Wasps and/or Bees (burrowing and digging) Mounds and nests made by soil-burrowing wasps and bees can interfere with play and the appearance of lawns and fields. Some large species, such as the cicada killer, can cause fear among staff and users. Treatment against bees on lawns and landscapes is discouraged. When treatment against wasps is deemed necessary, application should be made in the evening when foraging adults have returned to the nest, and by thoroughly spraying or dusting the entrance to the nest. Few insecticides are registered specifically for management of bees and wasps on turf, but organophosphate and pyrethroid insecticides (IRAC 1B and 3A) registered for perimeter treatment and areas near the perimeters may be used (read labels carefully for restrictions). 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.	alpha-cypermethrin (3A)	Fendona CS	G, L, R	0.5 – 1 fl oz
	bifenthrin (3A)	OnyxPro	A, C, G, L, R, S	0.3 fl oz
		Baseline, UP-Star EC	A, C, L, R	0.3 fl oz
	deltamethrin (3A)	DeltaGard G	L	2 – 3 lb
		Suspend SC	L	0.25 – 1.5 fl oz
White Grubs White grubs are larvae of May/June beetles (*Phyllophaga* species), green June beetle, masked chafers, black turfgrass ataenius, oriental beetle, Asiatic garden beetle, Japanese beetle, and other scarab beetles. *Identification:* All white grubs are creamy white in color, and with a brown head and three pairs of legs. Their bodies are C-shaped. Identification of white grub species is based on the raster (area of spines, hair and bare spaces on the underside of the last abdominal segment). May/June beetle grubs are the most common white grub species in SC, which has a raster pattern that resembles closed zipper. Southern and northern masked chafer grubs have a patch of evenly spaced spines as raster pattern. Japanese beetle grub raster pattern is that of V-shape. Green June beetle grubs crawl on their back, not on their bellies. Identifying the white grub species is important in understanding the life cycle and selecting the most effective management approach.	azadirachtin (UN)	AzaGuard, Molt-X, Ornazin 3% EC	A, C, G, L, R, S	8 – 21 fl oz
		Azatin O, NEEMIX 4.5	C, G, L, S	0.75 – 9 fl oz
		AzaSol	A, C, G, L, R, S	0.14 oz
	(azoxystrobin) + thiamethoxam (11 +4A)	Caravan G	A, G, L, R	2 – 2.8 lb
	Bacillus thuringiensis subsp. *galleriae*	grubGONE! G	A, C, G, L, R, S	2 lb 5 oz – 3 lb 7 oz
	Beauveria bassiana (UNF)	Botanigard 22 WP, Mycotrol WPO	A, C, G, L, R, S	1 – 4 oz
		Botanigard ES, Mycotrol ESO	A, C, G, L, R, S	2 – 8 fl oz
		Bioceres	G, L, R	1.1 – 2.2 oz
	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	8 – 16 tbsp
	carbaryl (1A)	Carbaryl 4L, Sevin SL	A, C, G, L, R, S	1.5 – 6 fl oz
		Sevin 7G	A, C, G, L, R, S	2.2 – 3 lb
	carbaryl + bifenthrin (1A + 3A)	ATP Duocide	A, L, R	4 – 8 lb
	chlorantraniliprole (28)	Acelepryn	A, C, G, L, R, S	0.18 – 0.37 fl oz
		Acelepryn G	A, C, G, L, R, S	1.15 – 2.3 lb

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
Damage and symptoms: White grubs live in the soil and feed on grass roots. Infested turf often appears wilted. Infested turf first turns yellow, then brown, and finally the brown patch dies and expands over time. Heavily damaged turf feels spongy underfoot. Damaged sods often fall into pieces when cut or lifted. Large green June beetle grubs also burrow to the surface at night and cause holes and small dirt mounds on the turf. *Life cycle:* May/June beetle grubs complete their life cycles in 2 to 3 years, whereas white grubs of other species have a one-year life cycle. Black turfgrass ataenius has two generations per year. The annual species overwinter as large grubs, which resume feeding in the spring, then pupate. Adults of annual species typically emerge in May and June, and lay eggs in June through July. Adult May/June beetles also emerge and reproduce in May through July, but their grubs have to develop over two or three years, so the adults of the next generation do not emerge until May or June of year 3 or 4. *Monitoring:* White grubs are usually detected through soil extraction and examination. Use a cup cutter or spade to remove 1 sq. ft. of sod with declining turf, break up the soil, and carefully inspect the root zone for white grubs. Pay particular attention to areas with high feeding and searching activity of black parasitic wasps and other animals digging for grubs. *Treatment threshold:* Various treatment thresholds have been suggested but have not been verified in the South. Generally, treatment is recommended when the density per square foot is 8 to 10 masked chafer grubs, 3 to 5 May/June beetle grubs, 8 to 10 Japanese beetle grubs, and 30 to 50 black turfgrass ataenius grubs. *Management:* Preventive application of neonicotinoids (IRAC 4A) and diamides (IRAC 28) in May through July is most effective in reducing the white grub population. Studies in SC suggested that these insecticides are effective for at least 45 days after application, which should cover the majority of the treatment window against egg hatch and young grubs. To narrow down the application timing, the predominant grub species should be identified, and the insecticides should be applied when the flight activity of the predominant scarab beetle species is peaking. Only one preventive treatment is needed each year. Curative treatment against larger grubs after August and in the spring is generally not effective and not recommended.	chlorantraniliprole + thiamethoxam (28 + 4A)	Acelepryn Xtra	A, G, L, R, S	2.3 – 4.6 fl oz
		Chlorpyrifos SPC 2, SPC 4	G	1.5 – 3 fl oz
		Chlorpyrifos 4E, Chlorpyrifos 4E-AG	G, S	0.75 – 3 fl oz
		Eraser, Govern, Lorsban-4E, etc.	S	1.5 – 3 fl oz
		Dursban 50W	S	4 – 8 lb/acre
	Chromobacterium subtsugae (UNB)	Grandevo PTO	A, C, G, L, R, S	4 – 8 oz
	clothianidin (4A)	Arena 0.25G	A, C, G, L, R, S	1.8 – 2.3 lb
		Arena 25 WDG, Guillotine	A, C, G, L, R, S	0.1 oz
	clothianidin + bifenthrin (4A + 3A)	Aloft LC G	A, C, L, R	2.3 – 3.6 lb
		Aloft GC SC	A, C, G, L, R, S	0.27 – 0.54 fl oz
		Aloft LC SC	A, C, L, R	
	clothianidin + pyriproxyfen (4A + 7C)	Sumari	A, C, L, R	1 – 2 fl oz
	cyantraniliprole (28)	Ference	A, C, G, L, R, S	0.184 – 0.367 fl oz
	dinotefuran (4A)	Zylam Liquid	A, C, G, L, R, S	1.8 fl oz
	dinotefuran + alpha-cypermethrin (4A + 3A)	Alucion 35 WG	G, L, R	0.44 oz
	Heterorhabditis bacteriophora (UC)	NEMAforce HB	A, C, G, L, R, S	25 – 100 million units
	imidacloprid (4A)	Bandit 0.5 G, Malice 75 WSP, Mallet 0.5 G, Merit 0.5 G	A, C, G, L, R	1.4 – 1.8 lb
		Mallet 7.1% PF	A, C, G, L, R, S	1.38 – 1.8 fl oz
		Midash 2SC, Merit 2F, Mallet 2F, etc.	A, C, G, L, R, S	0.46 – 0.6 fl oz
		ImidaGold 70DF, Merit 75 WP, etc.	A, C, G, L, R, S	3 – 4 tsp / 0.15 – 0.2 oz
		Bandit 0.5 G, Mallet 0.5 G, Merit 75 WSP	A, C, G, L, R, S	0.09 – 0.12 packet, 1.4 – 1.8 lb
	lambda-cyhalothrin + novaluron + pyriproxyfen (3A + 15 + 7C)	Proflex	A, C, G, L, R	12.8 ml
	lambda-cyhalothrin (3A)	Demand G	A, C, L, R	3 – 4 lb
		Avesta CS, Demand CS, Scimitar CS	A, C, L, R	7 ml
		Scimitar GC, Lambda GC-O	A, C, G, L, R, S	7 ml
		Lambda Select	A, G, C, L, R, S	6 ml
	novaluron (15)	Suprado	A, C, G, L, R, S	2.2 – 3 fl oz
	tetraniliprole (28)	Tetrino	A, G, L	0.367 – 0.735 fl oz

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Pest biology, symptoms, identification, monitoring, treatment	Pesticide Common Name (IRAC Number)	Pesticide Trade Name[1,2]	Use Sites[3]	Rate/1,000 sq. ft.
	thiamethoxam (4A)	Meridian 0.33G	A, C, G, L, R, S	1.4 – 1.8 lb
		Meridian 25WG	A, C, G, L, R, S	0.3 – 0.4 oz
	thiamethoxam + λ-cyhalothrin (4A + 3A)	Tandem	A, C, L, R	0.6 fl oz
	trichlorfon (1B)	Dylox 6.2 Granular	A, C, G, L, R	3 lb
		Dylox 420 SL	G, L, R	6.9 fl oz
	zeta-cypermethrin + bifenthrin + imidacloprid (3A + 3A + 4A)	Triple Crown Golf	A, C, G, L, R, S	0.8 fl oz
		Triple Crown T&O	A, C, L, R	
Wireworms Wireworms are larvae of click beetles, which are highly diverse and abundant in the Carolinas. Wireworms are usually 1.3 to 3.8 cm (0.5 to 1.5 inch) long, shiny, with a slightly flattened body light brown in coloration, and a flattened head rusty brown in coloration. Wireworms are mainly pests of agricultural crops but are reported on golf and lawn turf and sods. It is unclear which wireworm species is responsible for damage to turf. Wireworms feed on roots and stems of grasses, causing chlorotic or dead patches. Because wireworms often require two to six years to develop, the infestation can continue for years. There is currently no monitoring or management information available. No insecticide, except Zelto, is currently registered for wireworm management in turfgrass. Applications of contact insecticides may reduce adult population, but recommendation for timing is not possible at this time because the responsible click beetle species has not been conclusively identified. Management of wireworms may be similar to white grubs, or grubs of annual bluegrass weevil and billbugs, but insecticide efficacy has not been demonstrated.	heat-killed *Burkholderia* (UNB)	Zelto	A, C, G, L, R, S	8 – 16 tbsp

DISEASE CONTROL

Joseph A. Roberts
Extension and Research Plant Pathologist

Diseases can be 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 tebuconazole 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 as do long-term overcast, rainy weather periods. 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, light exposure, and drainage plus 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.	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Daconil Action	chlorothalonil + acylbenzolar-S-methyl 6.112F	2-5.4	7-14
	Daconil Weather Stik	chlorothalonil 6F	2-3.6	7-14 preventive
			4-5.5	14 curative
	Daconil Zn	chlorothalonil 4.16F	3-6	7-14 preventive
			6-11	7-14 curative
	Daconil Ultrex, Chlorothalonil 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
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14
	Spectro 90	chlorothalonil + thiophanate methyl 90WDG	2-5.76	7-14
	Concert II	chlorothalonil + propiconazole 4.3SC	3-8.3	7-28
	Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
	Kocide	copper hydroxide 53.8%	16 oz in 5 gal water	variable
	Secure, Fluazinam 40SC Select	fluazinam 4.17SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Fame + C	fluoxastrobin + chlorothalonil 4.25SC	3-5.4	7-14
	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
	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. Copper hydroxide products may be phytotoxic; read label carefully and use precautions.			
Anthracnose leaf blight & **Anthracnose basal rot** (*Colletotrichum cereale)* Creeping bentgrass & Annual Bluegrass primarily. The causal fungus can infect leaves, sheaths, and tillers. In creeping bentgrass and *Poa annua*, 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 of greens, other pests, fertility imbalances, or moisture extremes. Thatch removal and/or dilution through regular topdressing will be helpful. In bentgrass greens, manage localized dry spots to prevent anthracnose basal rot from developing.	Heritage, Azoxy 50WDG	azoxystrobin 50WDG	0.2-0.4	14-28
	Heritage TL	azoxystrobin 0.8TL	1-2	14-28
	Heritage G, AzProp G Select	azoxystrobin 0.31G	2-4 lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-28
	Headway G	azoxystrobin + propiconazole 1.06G	2-2.5 lb	14
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Daconil Action	chlorothalonil + acylbenzolar-S-methyl 6.112F	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Daconil WeatherStik, Chlorothalonil 720 SFT, others	chlorothalonil 6F	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
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14
	Concert II	chlorothalonil + propiconazole 4.3SC	4.5-8.3	14-28
	Instrata	chlorothalonil + propiconazole + fludioxonil 3.6SC	2.75-6	14-28
	Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3SC	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
	Secure, Fluazinam 40SC Select	fluazinam 4.17SC, 20SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Medallion	fludioxonil 50WP	0.25-0.5	14
	Medallion	fludioxonil 1.04SC	1-2	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271SC	2.135-6	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	7-14
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	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)
	Interface	iprodione + trifloxystrobin 2.27SC	5-7	14-21
	Duosan	mancozeb + thiophanate methyl	3	5-14
	Maxtima	mefentrifluconazole 3.34SC	0.4-0.6	14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.28-0.37	14-21
	Eagle	myclobutanil 20EW	1.2	14-21
	Velista	penthiopyrad 50WDG	0.3-0.5	14
	Affirm	polyoxin 11.3%WDG	0.88	7-14
	Endorse	polyoxin 2.5WP	4	7-14
	Appear, Appear II	potassium phosphite 4.1L	4-8	14
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	1-2	14-28
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6SC	0.6	14-28
	Mirage Stressgard	tebuconazole 2SC	1-2	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
	3336DG	thiophanate methyl 2%	3-9 lb	14
	TwoSome Fungicide	thiophanate methyl + iprodione	1.0-4.0	14-21
	Bayleton	triadimefon 50 WSP, 41.7Flo	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Trinity	triticonazole 1.7SC	0.5-1	14-28
Brown Ring Patch (*Waitea circinata* var. *circinata*) *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 *W. zeae* and *W. 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
	Heritage Action	azoxystrobin + acibenzolar-	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
	Headway, Compendium	azoyxystrobin +	1.3-3.0	14-28
	Ascernity	benzovindiflupyr +	1.0	14-21
	Renown	chlorothalonil +	2.5-4.5	14-21
	Concert II	chlorothalonil +	3-5.5	14-21
	Reserve	chlorothalonil + triticonazole	3.2-5.4	14-28
	Secure	fluazinam 4.17 SC	0.5	14
	Traction, Fairview	fluazinam + tebuconazole	1.3	14-21
	Medallion	fludioxonil 50%WP	0.25-0.5	7-14
	Medallion	fludioxonil 1.04 SC	1-2	7-14
	Tuque exoGEM	fludioxonil +	1.5-2.87	14-21
	Pedigree	flutolanil 3.8 SC	3.25-4.4	30 pre-disease
			4.4-6.6	30 post-disease
	Xzemplar	fluxapyroxad 2.47 SC	0.26	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Lexicon	fluxapyroxad +	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole	3	14-28
	Maxtima	mefentrifluconazole 3.34SC	0.6	14
	Navicon Intrinsic	mefentrifluconazole +	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.37	14-21
	Velista	penthiopyrad 50WDG	0.5	14
	Affirm	polyoxin 11.3%WDG	0.88	7-14
	Endorse	polyoxin 2.5WP	4	7-14
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity XT	pydiflumetofen +	1.5-3.0	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	0.4-0.7	14-28
	Honor Intrinsic	pyraclostrobin + boscalid	1.11	14-28
	Pillar G	pyraclostrobin + triticonazole	3.0 lb	28
	Aramax, Pillar SC	pyraclostrobin + triticonazole	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	1-2	14-28
	Trinity	triticonazole 1.7SC	1-2	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
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 >75ºF. Excessive N, thatch buildup, and excessive moisture favor disease. Improved varieties can offer some resistance. 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.	Heritage, Azoxy 50WDG	azoxystrobin 50%WG	0.2-0.4	14-28
	Heritage TL	azoxystrobin 0.8 TL	1-2	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Heritage G, AzProp G Select	azoxystrobin 0.31G	2-4 lb	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	0.65-3.0	14-28
	Headway G	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.5-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	Teramec SP	chloroneb 65SP	3-4	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
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75-8	7-14
	Concert II	chlorothalonil + propiconazole 4.3SC	3-8.3	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Instrata	chlorothalonil + propiconazole + fludioxonil 3.6SC	2.75-6	14-21
	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 5.3SC	3-6	14-21
	Secure, Fluazinam 40SC Select	fluazinam 4.17 SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Medallion	fludioxonil 50%WP	0.25 -0.5	7-14
	Medallion	fludioxonil 1.04 SC	0.75-2	7-14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	2.25-2.87	14-28
	Exteris	fluopyram + trifloxystrobin 0.271SC	2.135-6	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	1.2-4.6lb	14-28
	Pedigree	flutolanil 3.8SC	2.2-3.25	14-21 pre-disease
			4.4	14 post-disease
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-28
	Xzemplar	fluxapyroxad 2.47 SC	0.21-0.26	14-21
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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 2.27SC	2-6	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Tekken	isofetamid + tebuconazole 1.8SC	3	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
	Pinpoint	mandestrobin 4SC	0.31	14
	Maneb plus Zinc	maneb (37%) + zinc F	4.8	7-14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.28-0.37	14-21
	Eagle, Myclobutanil 20EW	myclobutanil 20EW	1.2	14
	Velista	penthiopyrad 50WDG	0.3-0.5	14-21
	Affirm	polyoxin 11.3%WDG	0.88	7-14
	Endorse	polyoxin 2.5WP	4	7-14
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	1-2	14-21
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity Forte	pydiflumetofen + azoxystrobin + propiconazole 2.5SE	0.63-0.84	14-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	0.4-0.7	14-28
	Honor Intrinsic	pyraclostrobin + boscalid 28G	0.55-1.1	14-28
	Pillar G	pyraclostrobin + trticonazole 0.81G	3.0 lb	14-28
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	14-28
	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
	3336DG	thiophanate methyl 2%	6-9 lb	14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	TwoSome Fungicide	thiophanate methyl + iprodione	1.0-4.0	14-21
	Spotrete F	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
	Trinity	triticonazole 1.7SC	0.75-2.0	14-28
	note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
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.	Ascernity	benzovindiflupyr +	1.0	14
	Daconil Ultrex	chlorothalonil 82.5WDG	3.2	7-10
	Daconil Action	chlorothalonil +	4-5.4	14
	Chlorothalonil DF	chlorothalonil 82.5DF	3.2	7-10
	Daconil WeatherStik, Chlorothalonil 720 SFT,	chlorothalonil 6F	3.7-5	14
	Daconil Zn, Chlorothalonil 500 Zn,	chlorothalonil + Zn 4.16F	4-5.5;6-8	14
	Encartis	chlorothalonil + boscalid	4	14
	Renown	chlorothalonil +	5.9	7-14
	Concert II	chlorothalonil +	5.5-8.3	14
	Consyst	chlorothalonil + thiophanate	3-8	14
	Spectro 90	chlorothalonil + thiophanate	3-5.76	7-14
	Traction, Fairview	fluazinam + tebuconazole	1.3	14
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	7-14
	Tekken	isofetamid + tebuconazole	3	14-28
	26/36	iprodione + thiophanate	2-4	14-21
	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	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,	2-4	14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	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 F	thiram 4F	3.75-7.5	14
	Bayleton	triadimefon 50WSP, 4.15F	0.5-1	3-10
Curvularia Blight (*Curvularia* spp.) **Curvularia Ink Spot (*Curvularia malina*)** Bermudagrass and Zoysiagrass. Usually associated with stressed plants from heat, excess moisture, drought, compaction, or other causes. Alleviate stress conditions that may occur.	26/36	iprodione + trifloxystrobin 2.27SC	5-7	14
	3336F	thiophanate methyl 41%F	4-8	7-14
	3336 WP	thiophanate methyl 50WP	4-8	7-14
Dead Spot (*Ophiosphaerella agrostis*) Creeping bentgrass, rarely Poa trivialis & 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, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3	14
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14
	Emerald	boscalid 70WG	0.13-0.18	14-28
	Encartis	chlorothalonil + boscalid 6.25SC	4	14
	Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
	Medallion	fludioxonil 50%WP	0.3-0.5	14
	Medallion	fludioxonil 1.04SC	1.15-2	14
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	3336 F, 3336 plus	thiophanate methyl 4F, 2F	4-6	14
	3336	thiophanate methyl 50WP	4-6	14
	3336DG	thiophanate methyl 2%	6-9 lb	14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
Dollar Spot (*Clarireedia* spp.) Bahiagrass, bermudagrass, centipedegrass, creeping bentgrass, ryegrass, rough bluegrass, St. Augustinegrass, tall fescue, zoysiagrasses. 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 60-80ºF in spring and fall. Moisture from fog, dew, or irrigation initiates disease. Low soil moisture, thatch, low N and K favor disease. Improved varieties can offer some resistance. 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.	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	0.65-3.0	7-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	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, Chlorothalonil 720 SFT, others	chlorothalonil 6F	1-2	7-10 pre-disease
			2-3.6	7-21 pre-disease
			4-5.5	14 post-disease
	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 82.5WDG	1.8-3.2	7-10
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14-28
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	7-14
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	2.8-5.75	7-10
	Concert II	chlorothalonil + propiconazole 4.3SC	1.5-3	14
	Concert II Instrata	chlorothalonil + propiconazole 4.3SC	3-5.5	14-21
			5.5-8.3	14-28
		chlorothalonil + propiconazole + fludioxonil 3.6SC	2.75-7	14-28
	Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-21
	Spectro 90	chlorothalonil + thiophanate methyl 90WDG	2-5.76	7-21

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
	Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3SC	3-8	14-28
	Secure, Fluazinam 40SC Select	fluazinam 4.17SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	2.25-2.87	14-21
	Exteris	fluopyram + trifloxystrobin 0.271 SC	1.5-4.135	7-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-21
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	7-14
	Xzemplar	fluxapyroxad 2.47SC	0.16-0.26	14-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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 2.27SC	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
	Pinpoint	mandestrobin 4SC	0.17-0.31	14-21
	Maneb plus Zinc	maneb (37%) + zinc F	9.6-12.8	7-14
	Maxtima	mefentrifluconazole 3.34SC	0.2-0.4	14-28
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.18-0.37	14-21
	Eagle	myclobutanil 20EW	1.2	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Banner Maxx, Banner Maxx II	propiconazole 1.3ME	0.5-2	7-28
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity	pydiflumetofen 1.67SC	0.08-0.32	14-28
	Posterity Forte	pydiflumetofen + azoxystrobin + propiconazole 2.5SE	0.63-0.84	21-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.9	14 (suppression)
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	1-2	14-28
	3336 WP	thiophanate methyl 50WP	2-4	14
	3336 F, 3336 plus	thiophanate methyl 4F,2F	2-4	14-28
	TM 85WDG	thiophanate methyl 85WDG	0.67-1.3	14
	3336DG	thiophanate methyl 2%	1.5-6 lb	14
	TwoSome Fungicide	thiophanate methyl + iprodione	1.0-4.0	14-21
	Spotrete F	thiram 4F	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
	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 are potentially affected. 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	Heritage, Azoxy	azoxystrobin 50WDG	0.4	28
	Heritage TL	azoxystrobin 0.8TL	2	28
	Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
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.	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	5.75	28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-28
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	2.25-2.87	14-28
	Resilia	fluopyram + prothioconazole + propamacarb 3.25SC	4	14-28
	Xzemplar	fluxapyroxad 2.47SC	0.26	14-28
	Fame + C	fluoxastrobin + chlorothalonil 4.25SC	4.5.-5.9	21-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	28
	Pedigree	flutolanil 3.8SC	3.25	21-28 pre-disease
			6.6	30 post-disease
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Maxtima	mefentrifluconazole 3.34SC	0.8	28
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.85	28
	Pinpoint	mandestrobin 4SC	0.31	14
	Tourney	metconazole 50WDG	0.37	21
	Velista	penthiopyrad 50WDG	0.5-0.7	14-28
	Affirm	polyoxin 11.3%WDG	0.88	7
	Endorse	polyoxin 2.5WP	4	7
	Densicor	prothioconazole 4SC	0.195	14-28
	Posterity	pydiflumetofen 1.67SC	0.16-0.32	21-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.9	28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	28
	Bayleton	triadimefon 50DF,4.15F	1-2	14-21
	Tartan	triadimefon + trifloxystrobin 2SC	2.0	28
Microdochium Patch and **Pink Snow Mold** (*Microdochium nivale*) Cool season grasses, including bentgrass bluegrasses ryegrasses, and fescues; also non-overseeded bermudagrass putting greens and zoysia greens. 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 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.	Heritage, Azoxy 50WDG	azoxystrobin 50WDG	0.2-0.4	14-28
	Heritage TL	azoxystrobin 0.8TL	1-2	14-28
	Heritage G	azoxystrobin 0.31G	2-4 lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	1.35 or 0.77	Single App or 14
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway, Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-0.725	14-28
	Headway, AzProp Select, Contend B, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Ascernity, Contend A	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Renown	chlorothalonil + azoyxystrobin 5.17SC	2.5-4.5	14-21
	Concert II	chlorothalonil + propiconazole 4.3SC	5.5 8.3	14 28
	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3SC	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, Chlorothalonil 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 82.5DF	1.8-3.2	7-10
	Secure Fluazinam 40SC Select	fluazinam 4.17 SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Medallion	fludioxonil 50%WP	0.25-0.5	14
	Medallion	fludioxonil 1.04SC	1-2	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271SC	4.135-12.6	10-14
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Xzemplar	fluxapyroxad 2.47SC	0.26	14-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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 2.27SC	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.85	14-28
	Tourney	metconazole 50WDG	0.37-0.44	Late fall
	Eagle	myclobutanil 20EW	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, Banner Maxx II, others	propiconazole 1ME	2-4	Single application
	Densicor	prothioconazole 4SC	0.195	14-28
	Posterity	pydiflumetofen 1.67SC	0.08-0.16	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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	28
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	10-14
	Spotrete F	thiram 4F	3-12	Fall & spring
	3336, 3336 plus	thiophanate methyl 4F, 2F, 50WP	2-4	14
	3336DG	thiophanate methyl 2%	3-6 lb	14
	TM 85WDG	thiophanate methyl 85WDG	0.67-1.3	14
	TwoSome Fungicide	thiophanate methyl + iprodione	1.0-4.0	14-21
	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

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)
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, Azoxy 50WDG	azoxystrobin 50WG ; 2 sequential treatments allowed	0.2-0.4	14-28
	Heritage TL	azoxystrobin 0.8TL	1-2	14-28
	Heritage G	azoyxystrobin 0.31G	2-4 lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	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 82.5DF	1.8-3.2	7-10
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	10-14
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75	7-10
	Concert II	chlorothalonil + propiconazole 4.3SC	3-8.3	14-21
	Instrata	chlorothalonil + propiconazole + fludioxanil 3.6SC	2.75-6	14
	Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	7-14
	Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3SC	3-8	14-28
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14-21
	Medallion	fludioxanil 50WP	0.25-0.50	14
	Medallion	fludioxonil 1.04SC	1-2	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271SC	2.135-6	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	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, Banner Maxx II, others	propiconazole 1.3ME	1-2	14
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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)
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	14-28
	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, 4.15Flo	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.			
"Helminthosporium" Leaf Spot/ Melting Out (*Bipolaris, Curvularia,* and *Drechslera* spp.) Bahiagrass, bermudagrass, bluegrass, creeping bentgrass, ryegrass, St. Augustinegrass, zoysiagrasses. 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 68-95ºF during mild periods of spring and fall. Maintain a balanced fertility. Irrigate deeply in the mornings. Raise mower height during disease outbreaks. Reduce thatch. ***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.	Heritage, Azoxy 50WDG	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
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-21
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-21
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-21
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-21
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-21
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	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, Chlorothalonil 500 Zn,	chlorothalonil 4.16F	2.9	7-10 pre-disease
			2.9-5.1	7-21 post-disease

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	others		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
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14-21
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75	7-10
	Concert II	chlorothalonil + propiconazole 4.25SC	3-8.3	14-21
	Instrata	chlorothalonil + propiconazole + fludioxanil 3.6SC	2.75-6	14-21
	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
	Secure, Fluazinam 40SC Select	fluazinam 4.17SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Medallion	fludioxonil 50%WP	0.25-0.5	14-21
	Medallion	fludioxonil 1.04 SC	1-2	14-21
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271 SC	2.135-6	14-28
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-21
	Xzemplar	fluxapyroxad 2.47SC	0.26	14-21
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-21
	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	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
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Eagle	myclobutanil 20EW	1.2	14
	Velista	penthiopyrad 50WDG	0.3-0.5	14
	Affirm	polyoxin 11.3%WDG	0.88	7-14
	Endorse	polyoxin 2.5WP	4	7-14
	Banner Maxx, Banner Maxx II, others	propiconazole 1.3ME	1-2	14
	Posterity Forte	pydiflumetofen + azoxystrobin + propiconazole 2.5SE	0.63-0.84	14-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-21
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	3336	thiophanate methyl 50WP, 4F	4-6	7-14
	3336 plus	thiophanate methyl 2F	4-8	7-14
	3336DG	thiophanate methyl 2%	6-9lb	14
	TwoSome Fungicide	thiophanate methyl + iprodione	1.0-4.0	14-21
	Spotrete F	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
	Trinity	triticonazole 1.7SC	0.5-2.0	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
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, Azoxy 50WDG	azoxystrobin 50WDG	0.4	14-28 (1, 2 or 3 apps. in fall)
	Heritage TL	azoxystrobin 0.8TL	1-2	14-28
	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1 WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	Teramec SP	chloroneb 65SP	5	21-28
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-14
	Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
	Secure, Fluazinam 40SC Select	fluazinam 4.17 SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	2.87	28-42
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
	Prostar	flutolanil 70WP, 70WDG	2.2	30
	Pedigree	flutolanil 3.8SC	3.25	30
	Rayora	flutriafol 1.04SC	0.7-1.4	28
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	21-28
	Xzemplar	fluxapyroxad 2.47SC	0.21-0.26	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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 2.27SC	4	14-21
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WG	0.37	14
	Eagle	myclobutanil 20EW	2.4	Apply in fall before dormancy, repeat 28 days
	Velista	Penthiopyrad	0.5-0.7	14-28
	Affirm	polyoxin D 11.3%WDG	0.88	7-14
	Endorse	polyoxin D 2.5WP	4	7-14
	Banner Maxx, Banner Maxx II, others	propiconazole 1.3ME	3-4	1 app. in early fall, prior to symptoms
	Densicor	prothioconazole 4SC	0.195	14-28
	Posterity Forte	pydiflumetofen + azoxystrobin + propiconazole 2.5SE	0.63-0.84	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	1-2	28
	3336, others	thiophanate methyl 4F, 50WP	2-4	7 to 14
	3336 plus	thiophanate methyl 2F	2-4	7-14
	3336DG	thiophanate methyl 2%	1.5-6 lb	14
	Trinity	triticonazole 1.7SC	1-2	14-28
Pink Patch/Cream Leaf Blight (*Limonomyces roseipellis*) Cool season grasses, but occasionally on warm season such as centipedegrass or bermudagrass.	Heritage, Azoxy 50WDG	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)
Mats of mycelium that aggregate in clusters occur on leaves during 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. Judiciously increase nitrogen fertility. Irrigate infrequently but thoroughly to prevent drought stress.	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.31G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Concert II	chlorothalonil + propiconazole 4.3SC	5.5-8.3	14-21
	Reserve	chlorothalonil + triticonazole 4.8SC	3.2-4.5	14-28
	Secure, Fluazinam 40SC Select	fluazinam 4.17 SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271SC	2.135-6	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Prostar	flutolanil 70WP, 70WDG	1.5	21-28
	Pedigree	flutolanil 3.8SC	2.2	21-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8 SC	3	14-28
	Interface	iprodione + trifloxystrobin 2.27 SC	4	14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Velista	Penthiopyrad	0.3-0.5	14
	Banner Maxx, Banner Maxx II, others	propiconazole 1.3ME	1-2	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	14-28
	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 1.7SC	1-2	14-28
Powdery Mildew (*Blumeria graminis*) Most grasses; Kentucky bluegrass is especially susceptible. 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. Improve sunlight penetration and air movement or landscape the area with non-turfgrass plants that are shade tolerant.	Heritage, Azoxy 50WDG	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
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	1.3-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 1.06G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Concert II	chlorothalonil + propiconazole 4.3SC	4.5-8.3	14-28
	Consyst	chlorothalonil + thiophanate methyl 67WDG	2-8	7-21

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Spectro 90	chlorothalonil + thiophanate methyl 90WDG	3.72-5.76	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-21
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Junction	mancozeb + copper hydroxide 60DF	2-4	7-14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Eagle	myclobutanil 20EW	1.2	14-28
	Banner Maxx, Banner Maxx II, others	propiconazole 1ME	1-2	14-28
	Velista	Penthiopyrad	0.3-0.5	14
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	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 sign 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.	Heritage, Azoxy 50WDG	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
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	10-14
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	2.6-3	10-14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
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.	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	10-14
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	1.5	10-14
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Teramec SP	chloroneb 65SP	4	5-7
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	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
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 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	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
	Regulate Select	metalaxyl 4SC	0.5-1.0	10-21
	Biophos	phosphorous acid salts 4.52	8-16	14-21
	Alude	phosphorous acid salts 5.17F	5-10	7-14
	Serata	picarbutrazox 20WDG	0.4-0.6	14-21
	Appear, Appear II	potassium phosphite 4.1 lb/gal	3-6	7-14
	Banol	propamocarb 6S	1.3-4	7-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	3.0	14
	Insignia	pyraclostrobin 20 WDG	0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08 SC	0.4-0.7	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	10-14
	Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	14
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	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.			
Pythium Root Rot /**Pythium Root Dysfunction** (*Pythium arrhenomanes*, *P. aristosporum*, *P. volutum*) Creeping bentgrass primarily but also bermudagrass and seashore paspalum greens. 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, Azoxy 50WDG	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
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	10-14
	Headway, AzProp Select	azoxystrobin + propiconazole 1.4ME, 1.4SC	3	10-14
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1 WDG	0.2-0.4	10-14
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	1.5	10-14
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-21
	Segway	cyazofamid 3.33SC	0.45-0.9	14-21
	Koban	ethazole 30WP	2-5	7-14
	Terrazole	ethazole 35WP	2-4	10-14
	Resilia	fluopyram + prothioconazole + propamacarb 3.25SC	4	14-21
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	7-14
	Fame 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
	Signature Xtra	fosetyl Al 60WG	2-6	14-21
	Serata	picarbutrazox 20WDG	0.4-0.6	21
	Appear, Appear II	potassium phosphite 4.1 lb/gal	6-8	7-14
	Banol	propamocarb 6S	1.3-4	7-21

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	3.0	14
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14
	Note: Water into the root-zone, except phosphite 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. If irrigation waters have high carbonate and bicarbonate levels, manage with acidification.	Secure	fluazinam 4.17SC	0.5	14
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Interface	iprodione + trifloxystrobin 2.27 SC	2-6	14-28
	Fore	mancozeb 80WP	8	14
	Protect	mancozeb 75WP	8	14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Compass	trifloxystrobin 50WDG	0.15-.25	14-21
	Tartan	trifloxystrobin + triadimefon 50WP	0.6-1.2	14-28
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 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.	Heritage, Azoxy 50WDG	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
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28

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 - see new labels for details. ***Note:*** Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7SEC	1.3-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Daconil Action	chlorothalonil + acylbenzolar-s-methyl 6.112F	2-5.4	7-14
	Daconil Weather Stik, Chlorothalonil 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
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Encartis	chlorothalonil + boscalid 6.25SC	3-4	14
	Vitalonil	chlorothalonil + potassium phosphite 5.27SC	5.75	7-10
	Concert II	chlorothalonil + propiconazole 4.3SC	3-5.5	14
	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
	Secure, Fluazinam 40SC Select	fluazinam 4.17SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14
	Exteris	fluopyram + trifloxystrobin 0.271SC	1.5-4.135	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Prostar	flutolanil 70WP, 70WDG	1.5	21-28
	Pedigree	flutolanil 3.8SC	2.2	21-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	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 2.27SC	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
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.37	14-21
	Eagle	myclobutanil 20EW	1.2	14-21
	Velista	penthiopyrad 50WDG	0.3-0.5	14
	Affirm	polyoxin 11.3%WDG	0.88	7-14
	Endorse	polyoxin 2.5WP	4	7-14
	Banner Maxx, Banner Maxx II, others	propiconazole 1.3ME	2	14-21
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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)
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	1-2	14-28
	3336 WSP	thiophanate methyl 50WSP	2-4	14
	3336F	thiophanate methyl 4F	2-4	14
	3336DG	thiophanate methyl 2%	1.5-6 lb	14
	TM 85WDG	thiophanate methyl 85WG	0.67-1.3	14
	Spotrete F	thiram 4F	3.75-7.5	3-10
	Bayleton	triadimefon 50WSP, 4.17Flo	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
	note: Fore mancozeb formulations now have restrictions on use rates and maximum seasonal rates – see current label for details.			
Rust (*Puccinia & Uromyces* spp.) Bermudagrass, ryegrass, St. Augustinegrass, tall fescue, zoysiagrasses. Small yellow to orange or reddish-brown pustules on the leaves. Heavily infected areas appear 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, Azoxy 50WDG	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
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	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 4.16F	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

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Encartis	chlorothalonil + boscalid 6.25SC	4	14
	Concert II	chlorothalonil +propiconazole 4.3SC	4.5-8.3	14-28
	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 40SC Select	fluazinam 4.17 SC, 40SC	0.5	14
	Secure Action	fluazinam + acibenzolar-S-methyl 4.18SC	0.5	14
	Traction, Fairview Select	fluazinam + tebuconazole 3.24SC	1.3	14
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14-21
	Exteris	fluopyram + trifloxystrobin 0.271SC	1.5- 4.135	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
	Rayora	flutriafol 1.04SC	0.7-1.4	14-21
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-21
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Interface	iprodione + trifloxystrobin 2.27SC	2-6	14-28
	Protect DF	mancozeb 75DF	4	7-14
	Fore, others	mancozeb 80WP	4	7-14
	Fore F, others	mancozeb 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
	Pinpoint	mandestrobin 4SC	0.31	14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.37	14-21

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Eagle	myclobutanil 20 EW	1.2	14-28
	Banner Maxx, Banner Maxx II, others	propiconazole 1.3ME	1-2	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WDG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	2.0	28
	3336 plus	thiophanate methyl 2F	4-8	14-28
	3336	thiophanate methyl 50WP, 4F	4-6	14
	TM 85WDG	thiophanate methyl 85WG	2.35-3.53	14
	Spotrete F	thiram 4F	3.75-7.5	3-10
	Bayleton	triadimefon 50WSP, 4.17Flo	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
	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, & 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, Azoxy 50WDG	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
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7SEC	1.5-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	14-21
	Teramec SP	chloroneb 65SP	4	5-7
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14-21
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6lb	14-28
	Prostar	flutolanil 70WP, 70WDG	1.5	21-28
	Pedigree	flutolanil 3.8SC	2.2	21-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	14-28
	Bayleton	triadimefon 50WSP, 4.15Flo	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., & *Fuligo* sp.) All grasses. Bluish-gray encrustations on leaf blades. In spring & summer during heavy rain, prominent white or yellow slimy masses may develop. These are not parasites of turf. Brush off, mow, or wash off mold with a strong stream of water.	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
Spring Dead Spot - *(Ophiosphaerella korrae, O. narmari,* or *O. 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 fall once soil temperatures reach 70º F at a 2" depth for 5 consecutive days. 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. In considering new establishments, improved bermudagrass hybrids with enhanced winter survival can offer some resistance.	Heritage, Azoxy 50WDG	azoxystrobin 50WDG	0.4	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.
	Heritage TL	azoxystrobin 0.8TL	2	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	Fall, 2 apps. when conditions are conducive, reapply 28 days later.
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.4	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7SEC	2.6-3	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	1.5	14-28, 1 or 2 applications one moth prior to dormancy
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	Fall, 1 or 2 apps. 1 month prior to dormancy, reapply 14-28 days later.
	Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3SC	3-8	14-28
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14-28
	Resilia	fluopyram + prothioconazole + propamacarb 3.25SC	4	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28 fall
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28 fall
	Rayora	flutriafol 1.04SC	0.7-1.4	21-28
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	21-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	28 day
	Kabuto	isofetamid 3.3SC	0.5-3.2	Do not exceed 3.2 oz in a season; apply as single or split applications in fall
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Maxtima	mefentrifluconazole 3.34SC	0.6-0.8	28
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.85	28
	Eagle, Myclobutanil 20EW	myclobutanil 20EW	2.4	Fall, 28 days
	Velista	penthiopyrad 50WDG	0.5-0.7	Fall, 2 apps. 28 days
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	4	1-3 apps, 30 day interval
	Densicor	prothioconazole 4SC	0.195	14-28
	Posterity	pydiflumetofen 1.67SC	0.16-0.32	Fall, 2 apps, 28 days
	Posterity Forte	pydiflumetofen + azoxystrobin + propiconazole 2.5SE	0.63-0.84	Fall, 2 apps, 14-28 days apart with final application one month prior to dormancy
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	3.0	Fall, 2 apps, 28 days apart with first application one month prior to dormancy
	Torque	tebuconazole 3.6F	0.6-1.1	28
	Mirage Stressgard	tebuconazole 2SC	1.0-2.0	28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	3336	thiophanate methyl 4F, 50WP	4-8	Apply in fall before dormancy/reapply in spring when soil temperatures reach 55-60F.
	3336DG	thiophanate methyl 2%	6-9 lb	14
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.	Concert II	chlorothalonil + propiconazole 4.3SC	4.5-8.3	Fall or spring
	Enclave	chlorothalonil + iprodione + thiophanate methyl +tebuconazole 5.3SC	3-8	14-28
	Traction	fluazinam + tebuconazole 3.24SC	1.3	Single app
	Tekken	isofetamid + tebuconazole 1.8 SC	3	14-28
	Eagle	myclobutanil 20EW	1.2	14
	Banner Maxx, Banner Maxx II, 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
	3336DG	thiophanate methyl 2%	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 (*Gaeumannomyces graminis* var. *graminis*) Bermudagrass. **Take-all Root Rot** (same pathogen as above) St. Augustinegrass. (*G. graminis, G. graminicola, Candidacolonium cynodontis*, and *Magnaporthiopsis cynodontis*) Bermudagrass Disorder first appears as chlorotic patches 8-24" in diameter, usually 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.	Heritage Action	azoxystrobin + acibenzolar-	0.4	28
	Briskway	azoxystrobin +	0.5-1.2	14
	Daconil Action	chlorothalonil +	3.5	14
	Tuque exoGEM	fludioxonil +	1.5-2.87	28
	Resilia	fluopyram + prothioconazole	4	14-28
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-21
	Lexicon	fluxapyroxad +	0.34-0.47	Spring/fall see label
	Tekken	isofetamid + tebuconazole	3	14-28
	Maxtima	mefentrifluconazole 3.34 SC	0.8	28
	Navicon Intrinsic	mefentrifluconazole +	0.85	14-28
	Densicor	prothioconazole 4SC	0.195	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Posterity XT	pydiflumetofen +	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WG	0.9	Spring/fall see label
	Insignia Intrinsic	pyraclostrobin 2.08SC	0.7	Spring/fall see label
	Honor Intrinsic	pyraclostrobin + boscalid	1.1	Spring/fall see label
	Pillar G	pyraclostrobin + triticonazole	3.0 lb	28
	Aramax, Pillar SC	pyraclostrobin + triticonazole	1.0	28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	2.0	28
	3336F	thiophanate methyl 41%F	4-8	7-14 in mid-July
	3336WP	thiophanate methyl 50WP	4-8	7-14 in mid-July
	3336DG	thiophanate methyl 2%	6-9 lb	14
	Bayleton	triadimefon 50WSP, 4.17Flo	1-2	21-28 Irrigate thoroughly after fungicide application to move into the root zone.
	Tartan	trifloxystrobin + triadimefon 2SC	1.5-2.0	28
Take-all Patch (*Gaeumannomyces graminis* var. *avenae*) Primarily 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. Utilize 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 practices.	Heritage, Azoxy 50WDG	azoxystrobin 50%WG	0.4	2 apps, 28 days apart in spring & fall.
	Heritage TL	azoxystrobin 0.8TL	2.	2 apps, 28 days apart in spring & fall.
	Heritage G	azoyxystrobin 0.31G	2-4lb	28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	2 apps, 28 days apart in spring & fall.
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.4	28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME, 1.4SC, 1.7SEC	2.6-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	3.5-4 lb	28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	5.75	28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Concert II	chlorothalonil + propiconazole 4.3SC	8.3	14 Spring and Fall
	Reserve	chlorothalonil + triticonazole 4.8SC	3.2-5.4	14-28
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	28
	Resilia	fluopyram + prothioconazole + propamacarb 3.25SC	4	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.36-0.4	28 fall & spring
	Fame G	fluoxastrobin 0.25G	2.3-4.6lb	28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.47	28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Tourney	metconazole 50WDG	0.37	1-2 apps/ fall
	Pinpoint	mandestrobin 4SC	0.31	14
	Maxtima	mefentrifluconazole 3.34SC	0.8	28
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.85	14-28
	Eagle	myclobutanil 20EW	2.4	Fall/spring 28 day
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	2-4	Up to 2 apps. in spring & fall.
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	3.0	21 fall & spring
	Insignia	pyraclostrobin 20WDG	0.9	2 apps, 28 days apart in spring & fall
	Insignia Intrinsic	pyraclostrobin 2.08SC	0.7	28
	Honor Intrinsic	pyraclostrobin + boscalid 28WG	1.1	28
	Pillar G	pyraclostrobin + triticonazole 0.81G	3.0 lb	28
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	2.0	14-28
	3336	thiophanate methyl 50WP, 4F	4-6	When disease symptoms appear, 7-14 day interval.
	3336 plus	thiophanate methyl 2F	4-8	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	3336DG	thiophanate methyl 2%	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)
Rhizoctonia Leaf and Sheath Spot (*R. zeae* & *R. oryzae*) Bermudagrass, centipedegrass, creeping bentgrass, St. Augustinegrass, tall fescue, seashore paspalum. 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. Avoid the use of ammonium sulfate as a fertilizer source and be sure that fertilization is sufficient to support growth of turf.	Heritage	azoxystrobin 50WDG	0.4	14-28
	Heritage TL	azoxystrobin 0.8ME	2	14-28
	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
	Heritage Action	azoxystrobin + acibenzolar-	0.2-0.4	14-28
	Briskway	azoxystrobin +	0.5-1.2	14-28
	Headway, AzProp Select, Compendium	azoyxystrobin + propiconazole 1.4ME,	1.3-3	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	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 or	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 +	2.5-4.5	14-21
	Vitalonil	chlorothalonil + potassium	5.75-8	7-14
	Instrata	chlorothalonil + propiconazole +fludioxanil	2.75-6	14-21
	Spectro 90	chlorothalonil + thiophanate	3-5.76	14-21
	Medallion	fludioxonil 50%WP	0.25-0.5	14-21
	Medallion	fludioxonil 1.04 SC	1-2	7-14
	Tuque exoGEM	fludioxonil +	1.5-2.87	14-21
	Prostar	flutolanil 70WG	2.2-4.5	14-21
	Pedigree	flutolanil 3.8SC	3.25-4.4	14-21 pre-disease
			4.4-6.6	14 post-disease
	Kalida	flutriafol + fluindapyr 4SC	0.25-0.4	14-21
	Xzemplar	fluxapyroxad 2.47SC	0.21-0.26	14-21
	Lexicon	fluxapyroxad +	0.34-0.47	14-28
	Navicon Intrinsic	mefentrifluconazole +	0.85	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Velista	penthiopyrad 50WDG	0.3-0.5	14
	Densicor	prothioconazole 4SC	0.195	14-21
	Posterity XT	pydiflumetofen +	1.5-3.0	14-28
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	0.4-0.7	14-28
	Honor Intrinsic	pyraclostrobin + boscalid	1.1	14-28
	Pillar G	pyraclostrobin + triticonazole	3.0 lb	28
	Aramax, Pillar SC	pyraclostrobin + triticonazole	1.0	28
	note: chlorothalonil formulations have new maximum use rates depending 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.			
Summer Patch (*Magnaporthiopsis poae*) *Poa annua*, *Poa pratensis*, and creeping bentgrass. Bronze patches 4-8 inches in a frog-eye or solid patch develop in late spring and summer when rotted roots from infections cause symptoms to express in hot and dry conditions. Preventive fungicides are targeted when soil temperatures in spring reach 65 F at 2-inch depth at 2 pm for 5-6 consecutive days Utilize acidifying fertilizers, such as ammonium sulfate at rates of N agronomically acceptable for specific cool season grass species growth. Apply Mn at rates recommended by soil tests. Improve root health by aeration and other accepted cultural practices.	Heritage, Azoxy 50WDG	azoyxystrobin 50WG	0.4	28
	Heritage TL	azoxystrobin 0.8TL	2	28
	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	14-28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7SEC	1.3-3.0	14-28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	0.75-1.5	14-28
	Union	azoxystrobin + cyazofamid 0.79SC	2.9-5.75	14-28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14
	Instrata	chlorothalonil +propiconazole + fludioxanil 3.6SC	6-11	14-28
	Enclave	chlorothalonil + iprodione + thiophanate methyl + tebuconazole 5.3SC	3-8	14-28
	Concert II	chlorothalonil + propiconazole 4.3SC	8.3	Spring, 14
	Medallion	fludioxonil 1.04SC	2	Spring, 14-21

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	Spring, 14-21
	Resilia	fluopyram + prothioconazole + propamacarb 3.25SC	4	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.18-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Rayora	flutriafol 1.04SC	0.7-1.4	21-28
	Xzemplar	fluxapyroxad 2.47SC	0.26	14-28
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Maxtima	mefentrifluconazole 3.34 SC	0.8	21-28
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Tourney	metconazole 50WDG	0.37-0.44	Spring
	Eagle	myclobutanil 20EW	2.4	Spring, 14-28
	Velista	penthiopyrad 50WDG	0.3-0.5	14-28
	Densicor	prothioconazole 4SC	0.195	14-28
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	1.5-3.0	Spring, 14-28
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	28
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	2-4	Spring, 14-28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2 SC	1-2	14-28
	3336	thiophanate methyl 4F, 50WP	4-8	Spring, 7-21
	3336DG	thiophanate methyl 2%	6-9 lb	Spring, 7-21
	Bayleton	triadimefon 50%WSP, 4.17Flo	1-2	Spring, 30
	Compass	trifloxystrobin 50WG	0.2-0.25	14-28

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Tartan	trifloxystrobin + triadimefon 2SC	1.5-2.0	28
	Trinity	triticonazole 1.75SC	1-2	21-28
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, Azoxy 50WDG	azoyxystrobin 50WG	0.4	28
	Heritage TL	azoxystrobin 0.8TL	2	28
	Heritage G	azoyxystrobin 0.31G	2-4lb	14-28
	Azoxy 2SC Select	azoxystrobin 2.08SC	0.38-0.77	28
	Heritage Action	azoxystrobin + acibenzolar-s-methyl 51.1WDG	0.2-0.4	14-28
	Briskway Azoxy D Select	azoxystrobin + difenoconazole 1.67SC	0.5-1.2 0.3-0.725	14-28
	Headway, AzProp Select, Compendium	azoxystrobin + propiconazole 1.4ME, 1.4SC, 1.7 SEC	2.6-3.0	28
	Headway G, AzProp G Select	azoxystrobin + propiconazole 0.01G	2-4 lb	14-28
	AzTeb Select	azoxystrobin + tebuconazole 3.38SC	1.5	28
	Union	azoxystrobin + cyazofamid 0.79SC	5.75	28
	Ascernity	benzovindiflupyr + difenoconazole 0.86L	1.0	14-21
	Renown	chlorothalonil + azoyxystrobin 5.16SC	2.5-4.5	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
	Tuque exoGEM	fludioxonil + benzovindiflupyr 0.7EW	1.5-2.87	14-21
	Exteris	fluopyram + trifloxystrobin 0.271SC	2.135-6	14-28
	Fame, Floxcor	fluoxastrobin 4SC	0.2-0.4	14-28
	Fame G	fluoxastrobin 0.25G	2.3-4.6 lb	14-28
	Prostar	flutolanil 70WP, 70WDG	1.5	30 days
	Pedigree	flutolanil 3.8SC	2.2	21-28
	Tekken	isofetamid + tebuconazole 1.8SC	3	14-28
	Tourney	metconazole 50WDG	0.37-0.44	Late fall

Disease, Affected Grasses, Symptoms & Cultural Controls	Trade Name	Fungicides[1]	Rate (oz/1000 ft^2)	Application Interval (Days)
	Affirm	polyoxin 11.3%WDG	0.88	Late fall
	Endorse	polyoxin 2.5WP	4	7-14
	Banner Maxx, Banner Maxx II, Propiconazole 14.3, others	propiconazole 1.3ME	3-4	Late fall
	Posterity XT	pydiflumetofen + azoxystrobin + propiconazole 2.29SE	3.0	28
	Torque	tebuconazole 3.6F	0.6	28
	Mirage Stressgard	tebuconazole 2SC	1-2	21-28
	3336	thiophanate methyl 4F, 50WP	4-8	Late fall
	3336DG	thiophanate methyl 2G	6-9 lb	Late fall
	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 leaves, and leaves will shred longitudinally. Improve drainage, sunlight penetration; relieve compaction; provide good growing conditions.	Signature	fosetyl Al 80WDG	4-8	14-21
	Signature Xtra	fosetyl Al 60WDG	2-6	14-21
	Lexicon	fluxapyroxad + pyraclostrobin 4.17SC	0.34-0.47	14-28
	Subdue Maxx, Mefanoxam 2AQ	mefanoxam 2ME	0.5-1	10-21
	Subdue G	mefanoxam 1G	12.5-25lb	10-14
	Navicon Intrinsic	mefentrifluconazole + pyraclostrobin 3.34SC	0.7-0.85	14-28
	Subdue	metalaxyl 2MEC	1-2	10-21
	Regulate Select	metalaxyl 4SC	0.5-1.0	10-21
	Insignia	pyraclostrobin 20WG	0.5-0.9	14-28
	Insignia Intrinsic	pyraclostrobin 2.08SC	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
	Aramax, Pillar SC	pyraclostrobin + triticonazole 3.14SC	1.0	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, Azoxy 2SC Select, Azoxy 50WDG Select, Scotts Disease EX
azoxystrobin + acibenzolar-S-methyl	Heritage Action
azoxystrobin + chlorothalonil	Renown
azoxystrobin + difenoconazole	Briskway, Azoxy D Select
azoxystrobin + propiconazole	Headway, Headway G, Contend B, AzProp Select, AzProp G Select, Compendium
azoxystrobin + tebuconazole	AzTeb Select
azoxystrobin + cyazofamid	Union
benzovindiflupyr + difenoconazole	Ascernity, Contend A
boscalid	Emerald
boscalid + chlorothalonil	Encartis
boscalid + pyraclostrobin	Honor, Honor Intrinsic
chloroneb	Teremec SP
chlorothalonil	Daconil formulations, Chlorothalonil WG, Chlorothalonil 720 SFT, Manicure, Thalonil, Concorde, Echo, others
chlorothalonil + acibenzolar-S-methyl	Daconil Action
chlorothalonil + boscalid	Encartis
chlorothalonil + fludioxonil + propiconazole	Instrata
chlorothalonil + iprodione + tebuconazole + thiophanate methyl	Enclave
chlorothalonil + potassium phosphite	Vitalonil
chlorothalonil + propamocarb hydrochloride	Lesco Par Systemic Fungicide
chlorothalonil + propiconazole	Concert, Concert II
chlorothalonil + thiophanate	ConSyst, Spectro 90, TM/C
chlorothalonil + triticonazole	Reserve
copper hydroxide + mancozeb	Junction
cyazofamid	Segway
ethazole	Koban, Terrazole
fluazinam	Secure, Fluazinam 40SC
fluazinam + acibenzolar-S-methyl	Secure Action
fluazinam + tebuconazole	Traction, Fairview Select
fludioxonil	Medallion
fludioxonil + benzovindiflupyr	Tuque exoGEM
fluindapyr + flutriafol	Kalida
fluopyram + trifloxystrobin	Exteris Stressgard
fluopyram + prothioconazole + propamocarb	Resilia
fluoxastrobin	Fame, Fame G
flutolanil	Prostar, Pedigree
flutolanil + thiophanate methyl	SysStar
fluopicolide + propamocarb	Stellar
flutriafol	Rayora
fluxapyroxad	Xzemplar
fluxapyroxad + pyraclostrobin	Lexicon Intrinsic 4.2SC
fosetyl Al	Aliette, Aliette Signature, Chipco Signature, Signature Xtra, Prodigy, Fosetyl Al 80WDG
iprodione	Chipco 26GT Flo, Iprodione Pro, Ipro 2SE, others
iprodione + thiophanate	Scotts Fluid Fungicide, 26/36
iprodione + trifloxystrobin	Interface
isofetamid	Kabuto 3.3SC

isofetamid + tebuconazole	Tekken 1.8L
mancozeb	Fore, Dithane T&O, Tersan LSR, Manzate 200 Flowable, Protect T/O, Pentathlon DF, + others
mandestrobin	Pinpoint
maneb	Manex, Maneb + zinc, Dithane M-22 Special, plus others
mefenoxam	Subdue Maxx, Mefanoxam AQ, others
mefentrifluconazole	Maxtima
mefentrifluconazole + pyraclostrobin	Navicon Intrinsic
metalaxyl	Subdue 2E, Pythium Control, Regulate Select, 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, Banner Maxx II, Alamo, Propiconazole 14.3
phosphorous acid salts	Alude, Appear, Appear II, Magellan, Biophos, Resyst, Vital
picarbutrazox	Serata
propamocarb	Banol
prothioconazole	Densicor
pydiflumetofen	Posterity
pydiflumetofen + azoxystrobin + propiconazole	Posterity Forte, Posterity XT
pyraclostrobin	Insignia, Insignia Intrinsic
pyraclostrobin + triticonazole	Pillar G, Pillar G Intrinsic, Pillar SC, Aramax
tebuconazole	Torque, Mirage 2L, others
thiophanate methyl	Cleary 3336, Fungo, SysTec 1998, TM 4.5F, TM 85WDG
thiophanate methyl + iprodione	TwoSome
thiram	Spotrete-F, plus others
triadimefon	Bayleton, Scotts Proturf Fungicide 7, Accost 1G, Granular Turf Fungicide, Strike 25WP
triadimefon + trifloxystrobin	Tartan 2.4SC, Armada 50WP
trifloxystrobin	Compass
triticonazole	Trinity

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	Teremec SP
	Ethazole (Etridiazole)	Koban, Terrazole
	(Quintozene)	Terraclor, PCNB, Engage, Revere, Penstar, Turfcide
Benzimidazoles, (Upward Mobile; Curative and Protective)	Thiophanate Methyl	3336F, 3336Plus Systec 1998, Fungo Flo,
Benzonitrile/Nitriles, (Contact; Protective)	Chlorothalonil	Daconil Ultrex, Daconil Weatherstik, others
Benzothiadiazole	Acibenzolar-S-methyl	Daconil Action (+ chlorothalonil), Heritage Action (+ azoxystrobin), Secure Action (+ fluazinam)
Carbamates, (Upward Mobile; Curative and Protective)	Propamocarb Hydrochloride	Banol, Resilia (+ fluopyram + prothioconazole)
Carboxilic Acid Amid	Fluopicolide	Stellar (+ propamocarb)
Demethylation Inhibitors (DMI), (Upward Mobile; Curative and Protective)	Difenoconazole	Briskway (+ azoxystrobin)
	Flutriafol	Rayora, Kalida (+ fluindapyr)
	Myclobutanil	Eagle WSP
	Propiconazole	Banner, Banner Maxx, Banner Maxx II, Headway (+ azoxystrobin), Contend B (+ azoxystrobin), Compendium (+ azoxystrobin)
	Triadimefon	Bayleton, Scotts Proturf Fungicide 7, Tartan (+ trifloxystrobin)
	Mefentrifluconazole	Maxtima, Navicon (+ pyraclostrobin)
	Metconazole	Tourney
	Myclobutanil	Eagle, Golden Eagle
	Prothioconazole	Densicor, Resilia (+ fluopyram + propamocarb)
	Tebuconazole	Torque, Mirage, Traction (+ fluazinam), Kabuto (+ isofetamid)
	Triticonazole	Trinity
Dicarboximides, (Local-penetrant; Protective)	Iprodione	Chipco 26019, Chipco 26GT
Dithiocarbamates, (Contact; Protective)	Mancozeb	Fore, Tersan LSR, Dithane M-45, Manzate 200FL, Protect
	Maneb	Manex, security Maneb Spray, Dithane -22 Special
	Thiram	Spotrete-F
Phenyl Pyridinamine	Fluazinam	Secure, Secure Action (+ acibenzolar-S-methyl), Traction (+ tebuconazole)
Phenylpyrrole	Fludioxonil	Medallion, Tuque exoGEM (+ benzovindiflupyr)
Phosphonates, (Systemic; Curative and Protective)	Fosetyl-Al	Aliette, Chipco Signature, Signature Xtra Stressgard, Prodigy
	Phosphorous acid salts	Alude, Appear, Appear II, Magellan, Biophos, Resyst, Vital
Qii	Cyazofamid	Segway, Union (+ azoxystrobin)
SDHI (succinate dehydrogenase inhibitors, aka, carboxamides), (Upward mobile, Curative and Protective)	Carboxin	Cadan, Padan, Vitavax
	Flutolanil	Pedigree
	Benzovindiflupyr	Ascernity (+ difenoconazole), Contend A (+ difenoconazole), Tuque exoGEM (+ fludioxonil)
	Boscalid	Emerald, Honor (+ pyraclostrobin), Encartis (+ chlorothalonil)
	Fluindapyr	Kalida (+ flutriafol)

	Fluopyram	Exteris Stressgard (+ trifloxystrobin), Resilia (+ prothioconazole + propamocarb)
	Fluxapyroxad	Xzemplar, Lexicon (+ pyraclostrobin)
	Isofetamid	Kabuto, Tekken (+ tebuconazole)
	Oxycarboxin	Plantvax
	Penthiopyrad	Velista
	Pydiflumetofen	Posterity, Posterity Forte (+ azoxystrobin + propiconazole), Posterity XT (+ azoxystrobin + propiconazole)
Strobilurines (Qoi), (Upward mobile, Curative and Protective- azoxystrobin, methoxyacrylates) (local penetrant or mesostemic, curative and protective – trifloxystrobin)	Azoxystrobin	Heritage, Heritage Action (+ acibenzolar-S-methyl), Union (+ cyazofamid), Headway (+ propiconazole), Compendium (+ propiconazole)
	Fluoxastrobin	Fame
	Mandestrobin	Pinpoint
	Pyraclostrobin	Insignia, Honor (+ boscalid), Lexicon (+ fluxapyroxad), Navicon (+ mefentrifluconazole)
	Trifloxystrobin	Compass, Exteris (+ fluopyram)
Unknown	Picarbutrazox	Serata

NEMATODE CONTROL

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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 Clemson University Nematode Assay Laboratory for sample guidelines and damage thresholds and other important information:
http://www.clemson.edu/public/regulatory/plant_industry/pest_nursery_programs/plant_prob_clinic/nematode_assay.html

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	x	x	x			x
St. Augustinegrass	x		x	x	x	x
Bermudagrass	x	?	x	x	x	x
Zoysiagrass	x	?	x	x	x	x
Cool-season						
Creeping bentgrass	x	x	x	x	x	x
Tall fescue	x		x			x
Ryegrasses	x		x			x
Bluegrasses	x		x			x

[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.*
[6]Spiral nematodes are frequently found on all turfgrasses, but are not believed to cause serious damage in most circumstances unless populations exceed published thresholds.

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 liquids 1,3-Dichloropropene (Telone II) and metam-sodium (labeled as Vapam, Sectagon or Busan 1020). All 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.

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. Please refer to label as to whether product can be applied to bare ground. 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 re-contaminated 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

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 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 was documented in South Carolina 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**
Curfew (1,3-dichloropropene, 97.5%)	3-5 gal/A – Actively Growing Turfgrass	Special 24c special local need registration for golf course turf and athletic fields. These fumigants are injected into the soil with tractor-mounted equipment at a minimum depth of 5”. Site must be irrigated with irrigation or rainfall at 0.5” immediately after application.
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	
Granular Soil Fumigant	**Rate of Product/Broadcast**	**Comments**
Basamid Granular (dazomet 99%)	218-525 lb/A	This material 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. Restricted Use Product.

Nematicides for commercial turfgrass use.

Nematicide	Rate	Comments
Liquid		
Armorex	4.4 to 5.75 fl oz/1000 ft2 21-28 day interval	5.75 fl oz recommended for golf course greens, tees, and recreational sports fields. 4.4 fl oz recommended for golf course fairways and home lawns. Post-application irrigation should be made immediately after application to move product into the soil. Do not under-irrigate.
Curfew EC Soil Fumigant (1,3-dichloropropene 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.
Divanem (abamectin 0.15lb/gal))	3.125-6.25 fl oz/acre at 14-21 day interval or 6.25-12.2 fl oz/acre at 21-28 day interval	For nematode control on golf course greens, tees or fairways only. Apply in at least 2 gallons water/1,000 sq.ft. using spray nozzles which provide coarse droplets; spray onto dew or wet turf and immediately incorporate with 0.1 inch irrigation/acre. Addition of a soil wetting agent improves performance. For best results use 3 to 4 consecutive applications on a 14-28 day interval at rates noted. Combinations with Heritage, or Heritage Action fungicides are recommended to reduce fungal infections and promote healthier turf. 50 fl oz/acre/year is the allowed maximum.
Indemnify (fluopyram 3.34SC)	0.195-0.39 fl oz/1000 ft2 at a minimum 14 day interval	For nematode control in golf course, athletic field, commercial turf, sod farm and residential lawns. Apply in at least 2 gallons water/1,000 sq.ft. and incorporate with irrigation. The maximum allowed amount is 17.1 fl oz/acre/year for commercial turf or 15.5 fl oz/acre/year for residential turf. Curative spot treatments over smaller areas (no more than 10,000 sq.ft. each) can be made at a maximum of 0.39 fl oz/1000 sq.ft. up to 4 times per calendar year.
Resilia (fluopyram + prothioconazole + propamocarb 3.25SC)	4 fl oz/1000 ft2 at a minimum 14-28 day interval	For nematode control in golf course turfgrass. Apply in at least 1.38 gallons water/1,000 sq.ft. and incorporate with irrigation. The maximum allowed amount is 16 fl oz/1000 ft2/year
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	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 (¼-½ acre inch water) within 15 minutes of application in sandy soils. Immediate incorporation helps avoid potential phytotoxicity.
Neo-Tec S.O. Sesame Oil 70% Lecithin, water 30%	3.5 fl oz/1000 ft2 once a month	Apply in standard spray equipment to deliver desired rate; reapply once per month beginning in Spring and continue into fall. Post-application irrigation to move product off the leaf blades is recommended. Do not irrigate turf until the evening after treatment and do not apply to saturated soils.
Trigon Nematode Control Geraniol 2.5% Eugenol 0.2%	1-2 ga/acre applied in at least 50 gal H_2O per acre	Soil treatment for turf and landscape. Post application irrigation is recommended to move product to turfgrass crowns and root zone.
Zelto (Heat-killed *Burkholderia* spp. strain A396 cells and spent fermentation media	4-8 qt/acre	Apply in standard spray equipment to deliver desired rate; reapply every 2-4 weeks to maintain control. Product requires adequate soil moisture and needs post application irrigation at 0.125 to 0.25” within 24 hr of application

Nematicide	Rate	Comments
Liquid		
Crescendo (*Chromobacterium subtsugae* strain PRAA4-1 cells and spent fermentation media)	2-4 lb/acre	Special 2ee recommendation for control of nematodes in Bluegrass, Bentgrass, Bermudagrass, Dichondra, Fescue, Orchardgrass, Poa annua, Ryegrass, St. Augustine, Zoysia mixtures, and other grasses including grasses grown for seed. Mix dosage in sufficient water to provide thorough coverage of turf.
Granular		
Nimitz (Fluensulfone)	Apply 60-120 lb product per acre	For control of nematodes in Bermudagrass, St. Augustinegrass, Zoysiagrass, Centipedegrass, and Seashore Paspalum. Do not apply more than 240 lb product to a given turfgrass area per calendar year. Applications at 60 lb product per acre can be applied monthly for four consecutive months, 80 lb product per acre can be applied monthly for three consecutive months, and applications at 120 lb product per acre can be re-applied once 2-6 months following the initial application.

[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.

Characteristics of various commercial nematicides used in turf.

Characteristic	1,3-Dichloropropene (Curfew)	Abamectin (Divamen)	Fluopyram (Indemnify + Resilia)	Furfural (MultiGuard)
Best nematode activity	sting	root-knot, sting	root-knot, sting	sting
Site of activity	contact	contact	contact & systemic	contact
Longevity of activity	short (~1 month)	intermediate (~4 mo)	long (~8 mo)	intermediate (~4 mo)
Signal word	Warning	Warning	Caution	Warning
Restricted Use Product	yes	yes	yes (Resilia)	no
Use sites	golf, sod – custom application only	golf greens/tees, fairways	golf, sports fields, sod, lawns	golf greens/tees, sod

CARRIER WATER QUALITY INFLUENCES PESTICIDE STABILITY

Dara Park, PhD and Juang-Horng 'J.C.' Chong, PhD

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 hr 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 solids* 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	Terraclor	✓	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		
chlorpyrifos	Dursban	✓	×	×		
clothianidin	Arena	✓	✓	✓		
fipronil	TopChoice	✓	✓	NR		
imidacloprid	Merit	✓	Test	✓		
indoxacarb	Provaunt	✓	×	Test		
λ-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.

With herbicide resistant weeds on the rise, a table is provided on the currently available products and their modes of action. Rotating products with different modes of action or combining such products are two of the best practical means to avoid or at least significantly delays the occurrence of herbicide resistant weeds.

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.

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 G	Y	—	—	—
Diquat	Reward, Aquatrim II	—	—	—	Y
Glufosinate-ammonium	Cheetah Pro, Finale, Derringer	—	—	Y	Y
Glyphosate	Gly-Flo, Prosecutor, Razor, Roundup Pro & Pro Dry, Trailblazer, Touchdown Pro, + many others	—	—	Y	—
Glyphosate + diquat dibromide	QuickPRO, Prosecutor Swift Acting	—	—	Y	Y
Glyphosate + imazapic	Roundup Extended Control, Roundup 365	—	—	Y	—
Imazapyr	Arsenal	—	Y	Y	—
Imazapyr + diuron	Sahara	—	Y	Y	—
Metam sodium	Metam CLR 42, Sectagon-42, Vapam HL, Soil Prep, K-Palm HL	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 ft^2 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 by October, 2017. Some methyl bromide formulations are Restricted Use Pesticides.** Chloropicrin is added as a 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 morning-glory are not controlled by fumigants.
Metam-sodium (metham)	Vapam 33% (50 to 100 gal/A) Vapam HL 42% (30 to 75 gal/A) Sectagon	Non-selective	Both products 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 ft^2 in 2 to 5 gallons of water or 8 to 10 oz of Dazomet/100 ft^2. 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/100 ft^2. 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. Aeration may be required by rototilling before planting. Apply glyphosate + fuaziflop + triclopyr ester prior to fumigating to improve control. Metham is a dithiocarbamate herbicide member. **Read and follow all label directions. Both are restricted-use-pesticides**. Control of legumes, sedges from seed, and morning-glories with dazomet may be erratic.
Dazomet	Basamid 99 G (255 to 450 lb/A)		
glyphosate (4 lb ai/A)	Roundup Pro/4S Touchdown Pro + others (4 to 5 qt/A)	Torpedograss, bermudagrass, nutsedges, other perennial weeds. Non-selective.	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 2L at 24 oz/a can be mixed with glyphosate (4 lb/gal) at 3 qt/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. Adding 2 qt/ac Triclopyr Ester 4L to glyphosate + Fusilade also enhances control. For spot treatment, Glyphosate (4 lb/gal) is applied at 2 oz. per gallon of water; Reward 2EC is used at 4 teaspoons (0.75 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 1.5 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 lb)	QuickPRO 76 WG (4.5 to 9 lb/A) RazorBurn 3.11L (7.5 qt/A)		
glufosinate (0.75 to 1.5 lb ai/A)	Finale 1SC (0.75 to 1.5 gal/A) Cheetah Pro 2.34L (41 to 82 oz/A)		
diquat (1 lb ai/A)	Reward, Diquat 2L (0.5 gal/A)		
diquat + glyphosate + indaziflam (10.5 lb ai/A)	Specticle Total 1.95L (5.4 gal/A)	Total vegetation control	Mix 16 fl oz/gal of water to cover 1,000 ft^2. Maximum yearly use rate of 32 fl oz/1,000 ft^2. Make a subsequent application 4 months after the initial to extend weed control. For non-selective weed control in ornamental beds, apply only to established plants ($\geq$1 yr old) and prior to mulching.

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

Common Name	Trade Name (rate)	Weeds Controlled	Comments
pelargonic acid (see label)	Scythe (see label)	existing vegetation	Provides contact, nonselective control of treated green plant parts. Quick-acting, often within hours. Repeat applications will be needed on perennial plants. Fatty acid herbicide.

Note: EPA Soil Fumigation Information website: http://www2.epa.gov/soil-fumigants.

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. For 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)	Annual bluegrass	Bittercress, hairy	Chickweed, Common	Crabgrass	Goosegrass	Henbit	Field Madder	Foxtail, Yellow	Knotweed, Prostrate	Lawn Burweed	Phyllanthus sp.	Purslane	Pusley, Fla.	Speedwell spp.	Spurges	Woodsorrel (Oxalis)
atrazine (Aatrex)	E	E	E	F[1]	P	E	F	P	–	G	–	G	G	E	G	F
benefin (Balan)	G-E	P	G	G-E	F	G	P	G	P	P	–	–	–	P	P	–
benefin+oryzalin (XL)	G	P	G	E	F-G	G	G	G	G	–	–	G	G	–	F	F-G
benefin+trifluralin (Team)	G	–	G	F-G	F	G	–	G	–	–	–	–	–	–	F	F
bensulide (Betasan, PreSan)	F	P	P	G-E	P-F	P	P	G	–	P	–	F	–	P	–	–
bensulide + oxadiazon (Goose/Crab)	G-E	–	G	E	G-E	–	–	G	–	–	–	–	–	–	G	–
dimethenamid (Tower)	–	G	G	G	F-G	G	P	–	G	–	–	G	G	–	G	G
dithiopyr (Dimension)	G-E	G	G	E	G	G	P	G	G	F	–	F	–	G	G	G
indaziflam (Specticle)	E	G	–	E	E	–	–	G	–	–	–	–	–	–	–	–
isoxaben (Gallery)	P-F	E	E	P-F	P	G	F	P	E	E	–	G	F-G	G-E	G	G
mesotrione (Tenacity)	F	–	G	G	F-G	G	–	–	–	G	–	F	G	G	–	G
methiozolin (PoaCure)	G-E	G	G	G	F-G	–	–	–	–	–	–	–	–	G	–	–
metolachlor (Pennant)	G	–	F	F-G	P-F	–	–	G	–	–	P	F	G	–	F	P
napropamide (Devrinol)	G	–	E	G-E	F	P	–	–	–	E	–	G	P	E	P	G
oryzalin (Surflan)	G-E	P	G	E	F-G	G	G	G	G	F	–	G	G	P	F-G	G
oxadiazon + prodiamine	G-E	G	G	E	G-E	G	–	G	–	F	F-G	G	G	G	G	G
oxadiazon (Ronstar)	G-E	P	P	G-E	E	P	P	G	P	P	F-G	G	G	G	G	G
pendimethalin (Pendulum)	G-E	G	E	E	F-G	G	P	G	G	G	F-G	G	G	G-E	G	G
pethoxamid (StriCore)	G	F	F	G	F-G	F	–	G-E	F	–	–	F	G	F	G	F
prodiamine (Barricade)	G-E	G	G	E	F-G	G	P	G	G	F-G	F-G	G	G	F-G	G	G
pronamide (Kerb)	G-E	–	E	P-F	P	F-G	–	G	G	P	–	G		E	P	P
simazine (Princep T&O)	E	E	E	P-F	P	E	F	G	–	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 & depend on many factors such as environmental conditions, turfgrass vigor or health, application timing, etc., & 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	S	S	NR	S
isoxaben (Gallery)	NR	S	NR	S	S	S	S	S	NR	I-S	S	S	NR	S	S	S
mesotrione (Tenacity)	NR	NR	NR	NR	NR	NR	S	S	NR	NR	S-I	S-I	NR	S-I	S-I	NR
methiozolin (PoaCure)	NR	NR	S	S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR-S
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
pethoxamid (StriCore)	NR	S	NR	S	S	NR	S	S	S	–	S	S	S	NR	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.

Pre- and Post-emergence Herbicides for Putting Greens (*Refer to Herbicide Label for Specific Turf Species Use Listing*).

Active Ingredients	Trade Names	Weeds Controlled	Comments	Bentgrass	Poa/Bent	Bermudagrass	
						Non-overseeded	Overseeded
			Preemergence				
Bensulide	• Bensumec, Betasan, Pre-San	• Annual grasses, • Select broadleaves.	• PRE crab, goose & Poa control. • Only 2 applications yearly. • Use high rate in late summer for Poa.	Yes	≤50% Poa	—	Yes
Bensulide + oxadiazon	• Anderson's Goose/Crab Control	• Summer annual grasses.	• PRE crab & goosegrass. • To avoid injury, apply half rate (57 lb/A), repeat in 10 days. • Apply only to dry turf, water-in immediately. • Some yellowing may occur w/in 30 days of use.	Yes	—	Yes	—
Dithiopyr	• Anderson's Golf Fertilizers with dithiopyr	• Summer annual grasses, • Select broadleaves.	• Avoid stressed putting greens, especially with a poor root system. • Yellowing of Poa may occur during stressful conditions.	Yes	—	Yes	—
Methiozolin	• PoaCure	• Poa annua • Summer annual grasses • Some broadleaves	• PRE Bermuda/Bentgrass golf greens & fairways, • Need 4 to 6 yearly application	Yes	Yes (Poa control)	Yes	No
Pendimethalin	• Pendulum AquaCap	• Annual grasses, • Select broadleaves	• Label neither allows nor restricts bermudagrass greens.	—	—	Yes	—
Pronamide	• Kerb	• Annual grasses, • Select broadleaves.	• Label neither allows nor restricts bermudagrass greens.	—	—	Yes	—
Siduron	• Tupersan 50WP	• Crabgrass, • Bermudagrass suppression.	• Crabgrass control & bermuda suppression in bentgrass. • Band applications along bentgrass green perimeter to suppress bermudagrass stolons; apply prior bermuda green-up; repeats on 30 day intervals. Water-in applications.	Yes	—	—	—
			Postemergence				
2,4-D + MCPP + dicamba	• Eliminate LO, • Threesome, • Trimec Classic/ 899/Southern, • Triplet /Low Odor/Hi-D, • TruPower2/3.	• Broadleaf weeds.	• Rate limits on bent greens. • 2 applications/site/year. • May cause slight injury. • Do not apply above 85°F (29°C).	Yes	Yes	Yes	Yes
2,4-D + MCPP + dicamba	• Trimec Bentgrass Formula	• Broadleaf weeds.	• Contains less 2,4-D v Trimec Classic • Do not apply above 85°F (29°C). • 2 application/site/year.	Yes	—	—	Yes
2,4-D + MCPP + dicamba + pyraflufen ethyl	• 4-Speed, • RedZone 2	• Broadleaf weeds.	• Avoid heat or drought stressed turf. • Mild yellowing for ~1 week. • 2 applications/site/year.	Yes	Yes	Yes	Yes

Pre- and Post-emergence Herbicides for Putting Greens (***Refer to Herbicide Label for Specific Turf Species Use Listing***).

Active Ingredients	Trade Names	Weeds Controlled	Comments	Bentgrass	Poa/Bent	Bermudagrass	
						Non-overseeded	Overseeded
2,4-D + triclopyr + dicamba + pyraflufen ethyl	• 4-Speed XT	• Broadleaf weeds.	• Ditto from above.	Yes	Yes	Yes	Yes
2,4-D + dicamba + quinclorac	• 2DQ	• Broadleaf weeds.	• Avoid temps. >90°F (32°C). • 2 applications/site/year. • Label neither allows nor restricts bermudagrass greens.	Yes	—	Yes	—
Carfentrazone	• QuickSilver T&O	• Broadleaf weeds, • Silvery thread moss.	• Moss: 6.7 fl oz/a, every 2 wk at ≤85°F (29°C). • Poa damaged at >2.0 oz/a. • Add NIS at 0.25% (v/v). • Wait 75 days after bensulide use.	Yes	Yes	Yes	Yes
Dicamba	• Banvel • Diablo	• Broadleaf weeds	• Label neither allows nor restricts putting green use. • Avoid temps. >90°F (32°C).	Yes	Yes	Yes	Yes
Mecoprop (MCPP)	• Mecomec 2.5 + 4SL, • MCPP Amine	• Broadleaf weeds.	• Avoid temps. >90°F (32°C).	Yes	Yes	—	—
MCPP + MCPA + dicamba	• Trimec Encore, • Tri-Power.	• Broadleaf weeds.	• Rate limit on bent greens. • Avoid temps >85°F (29°C). • Mild yellowing may occur. • Label neither allows nor restricts bermudagrass greens.	Yes	Yes	Yes	Yes
Foramsulfuron	• Revolver	• Goosegrass, • Poa, overseeding.	• Removes overseeding & Poa + certain broadleaf weeds.	—	—	Yes	—
Trifloxysulfuron	• Monument 75WG	• Poa, overseeding, • Sedge/kyllinga, • Broadleaf weeds.	• Label neither allows nor restricts bermudagrass greens. • Add NIS at 0.25% (v/v).	—	—	Yes	—
Rimsulfuron	• TranXit, • QP Rimsulfuron 25DF	• Poa & overseeding.	• Removes overseeding + certain broadleaf weeds. • Add NIS at 0.25% (v/v).	—	—	Yes	Yes
Pronamide	• Kerb	• Poa & overseeding.	• Removes overseeding + certain broadleaf weeds. • 2(ee) label lists greens & tees. • Add NIS at 0.25% (v/v).	—	—	Yes	Yes

*Always consult and follow all label directions prior to use. Refer to the latest label version to confirm use on a particular grass or site.

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

COMMON NAME (lb ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (1 to 2 lb-sandy soil) (4 lb-muck soil)	**Atrazine** Aatrex 4L (1-2 qt), 90DG (1.1-2.2 lb), 80W (1.2-2.5 lb); 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 lb)	Pennant 7.8L (2 to 4 pt)	Pre-plant yellow nutsedge, annual sedge, sprangletop, some annual grasses	Pre-plant centipedegrass, 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 pt./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Irrigate within 7 days after application. Acetanilide herbicide.
oxadiazon (2 to 4 lb)	Ronstar 2G (100 to 200 lb) Ronstar 50W (4 to 6 lb) Ronstar Flo 3.17L (2.5 to 3.8 qt)	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 pt/a) or methylated seed oil (1.5 pt/a) to increase performance. Not labeled for golf greens or collars. Avoid drift onto ornamentals. Quinolinecarboxylic Acid herbicide.
siduron (8 to 12 lb)	Tupersan 50WP (16 to 24 lb)	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 (lb ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (2.0 lb-sandy soil) (4.0 lb-muck soil)	**Atrazine** Aatrex 4L (1-2 qt), 90DG (1.1-2.2 lb), 80W (1.2-2.5 lb); 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 lb)	Balan 2.5G (80 to 120 lb) 2.5 Benefin G (80 to 120 lb) Balan 1.5EC (1.3 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 (0.75 -1.13 lb) + trifluralin (0.75 -1.5 lb)	Team 2G (100 to 150 lb) Team Pro 0.86 G (175 to 350 lb)			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.
benefin (1-1.5 lb) + oryzalin (1-1.5 lb)	XL 2G (100 to 150 lb)			Same as for benefin. Dinitroaniline herbicide.
bensulide (7.5 to 12.5 lb)	Betasan 3.6G (209-348 lb) Pre-San, Lescosan 7G (107-180 lb) Pre-San 12.5G (60-100 lb) Bensumec, Lescosan 4E (1.9-3.1 gal) ProTurf Weedgrass Preventer 8.5G (88-147 lb)			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. Don't make more than 2 applications per year. Don't exceed 25 lb ai/A in a single year. Sulfonamide herbicide.

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

COMMON NAME (lb ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
oxadiazon (1½ lb) + bensulide (6 lb)	Goosegrass/Crabgrass Control 6.56 G (115 lb)	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 0.25 to 0.5-inch water. Do not overlap on greens.
dimethenamid-P (1 to 1.5 lb ai/acre) dimethenamid-P + pendimethalin (1.75 to 3.5 lb)	Tower 6L (21 to 32 oz) Freehand 1.75G (100 to 200 lb)	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 & pendimethalin is available as Freehand.1.75G with a yearly allowance of 400 lb/ac. Very long chain fatty acid inhibitor + mitotic inhibitor (pendimethalin).
dithiopyr (0.5 lb)	Dimension 1E (0.5 gal) Dimension Ultra 40WSP (0.95 lb)	Same as for benefin, plus oxalis (woodsorrel)		Same as for benefin. Do not use within 3 months of seeding or sprigging. A total of 1.5 lb ai/A is allowed yearly not to exceed 0.5 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. Anderson's Golf Products Fertilizers with dithiopyr is available for golf greens. Pyridine herbicide.
napropamide (2.0 lb)	Devrinol 50WP (4.0 lb) Devrinol 2G (100 lb) Devrinol 5G (40 lb)	Same as for benefin		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 (1.5 to 3 lb)	Surflan 4AS (1.5 to 3 qt)	Same as for benefin, plus goosegrass		Same as for benefin. Use a 1.5 + 1.5 lb ai/A split application ~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. Dinitroaniline herbicide.
pendimethalin (1.5 to 3.0)	Pendulum 60 DF Pendulum Aquacap (see label)	Same as for benefin plus oxalis and speedwell.		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 (0.75 to 1.5 lb)	Barricade 65WG (1.15 to 2.3 lb) Barricade 4L (1.5 to 3 pints) ProClipse 65 WDG (1.15 to 2.3 lb) RegalKade (check label)	Same as for benefin plus chickweed, spurge, goosegrass		Same as for benefin. Split applications at 0.38 to 0.75 lb 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. Dinitroaniline herbicide.

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

COMMON NAME (lb ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
flumioxazin (0.375 lb)	SureGuard 51WDG (12 oz/acre) StayGuard 0.125G (see formulation label, typically 300 lb/ac)	Winter annual broadleaf weeds, preemergence crabgrass, goosegrass	**Dormant** bermudagrass	SureGurad is 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 and StayGuard are granular formulation with less turf burn potential. Dicarboximide herbicide.
indaziflam (0.027 to 0.047 lb or 30 to 80 g ai/ha) 0.027 to 0.044 lb	Specticle 0.622L (5.4 to 10 oz)	Goosegrass, crabgrass, annual bluegrass plus various broadleaves	**Established** Bermudagrass, Zoysiagrass, Centipedegrass, St. Augustinegrass, Seashore paspalum	Do not use on cool-season turfgrasses or buffalograss. **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-season grasses. Use higher rate for PRE broadleaf weed control. Additional granular and fertilizer formulations are available. Cellulose biosynthesis inhibitor. Alkalyazine herbicide.
isoxaben (0.5 to 1 lb)	Gallery 75W (0.66 to 1.33 lb)	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, 0.5 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.
methiozolin (0.46 to 0.92 lb)	PoaCure 2.3 SC (0.2 to 0.4 gal)	*Poa annua, Poa trivialis,* crabgrass, goosegrass, some broadleaves	Creeping bentgrass Bermudagrass Kentucky bluegrass Fescues Zoysiagrass Seashore paspalum Kikuyugrass	Root absorbed. For use on non-overseeded greens and fairways. Apply in 30 to 200 GPA. Do not use an adjuvant. For Poa control on bentgrass greens, up to 6 applications are needed spaced 2 to 3 weeks apart starting in October. Apply only when average daily temperature is between 50 and 80F. Do not apply to stressed turf or discoloration may result. Do not overseed within 45 days of the last application or apply within 12 weeks of overseeding. Refer to the label for more information. Plant cell wall biosynthesis or tyrosine aminotransferase inhibitor.
metolachlor (1.25 to 2.5 lb)	Pennant Magnum 7.62 L (1.3 to 2.62 pt)	Yellow nutsedge, annual sedge, sprangletop, some annual grass (e.g., crabgrass) suppression	**Established** bermudagrass golf course fairways; zoysiagrass, centipedegrass 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 pt./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.

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

COMMON NAME (lb ai/acre)[2]	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
oxadiazon (2 to 4 lb)	Ronstar 2G (100 to 200 lb) Ronstar 50W (4 to 6 lb) Ronstar Flo 3.17L (2.5 to 3.8 qt)	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 lb/a (2 + 1 lb 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 lb/A (2 + 0.4 lb ai oxadiazon + prodiamine/A). Oxadiazole (or Triazolinone) herbicide. Oxadiazon will undergo new golf course restrictions in 2024 where 8 lb ai/ac is maximum annual use load with 4 lb ai/ac per has been reclassified as a restricted use product.
pethoxamid (0.5 to 1.5 lb)	StriCore 4L (16 t 48 fl oz)	Goosegrass, crabgrass, annual bluegrass, select broadleaves	Bahiagrass, Bermudagrass, Buffalograss, Carpetgrass, Centipedegrass, Kikuyugrass, Seashore Paspalum, Zoysiagrass	A repeat application ~75 days after the initial is needed for extended control. Do not seed or sprig into treated areas within 4 months of use. Sod should be established for 4 months before being treated or treated within 90 days of harvest. Label does not specify its use on warm-season golf greens. Control consistency improves when tank-mixed with another PRE herbicide such as dithiopyr, prodiamine, pendimethalin, or indaziflam. Chloroacetamid herbicde.
pronamide (0.5 to 1 lb)	Kerb T/O 3.3SC (1.25 to 2.5 pt)	Annual bluegrass	All warm-season grasses	Safe on all warm-season grasses. Water-in following application. 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 lb/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. 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; lb/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 hr 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	Ky. 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
carfentrazone + sulfentrazone (Dismiss NXT)	S	S	NR	S	S	S	S	S	S	S	S	S	S	S	S	S
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 + 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
2,4-D + dicamba + penoxsulam + sulfentrazone (Avenue So.)	S-I	NR	NR	S-I	S-I	NR	S-I	S-I	S-I	NR	S-I	S-I	S-I	S	S-I	S-I
2,4-D + triclopyr (Turflon)	NR	NR	NR-I	NR	NR	NR	NR	I	S	NR	S	S	NR-P	NR	S	NR
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
florasulam + halauxifen-methyl (Relzar)	S	S	NR	S	S	NR	S	S	S	S	NR	S	S	S	S	S
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
foramsulfuron + halosulfuron + thiencarbazone (Tribute)	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	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
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, Blade, MSM, Mansion)	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 Plus)	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
sulfentrazone + metsulfuron (Blindside)	NR	NR	NR	S	NR	NR	S	NR	S	NR	NR	NR	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
clethodim (Envoy)	NR	NR	NR	NR	NR	NR	S	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)[3]	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	I	I	NR	S
mesotrione (Tenacity)	NR	NR	NR	NR	S-I	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
pinoxaden (Manuscript)	NR	NR	NR	S	NR	NR	NR	NR	NR	NR	NR	NR	NR	I	NR	S
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
topramezone (Pylex)	NR	I-S	NR	I	NR	NR	S	S	S	NR	NR	S	I	I-S	S	NR
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	Signalgrass
amicarbazone (Xonerate)	F-G	P	F-G	—	P	P	P	P	P	P	P	P	—	G-E
atrazine (Aatrex)	P-F[2]	P	G-E	F	P	P	G-E	F-G	F	P	F	P-F	F	P
asulam (Asulox)	G	F	P	F	P	P-F	–	F	P	G	P	P	–	G
clethodim (Envoy)	E	G-E	G	G	--	–	G-E	–	–	–	P	G	G	—
DSMA, MSMA	G	F	P	G	F-G	F-G	P	P	F	G	P	P	—	F
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	—	—	—	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-G	—	E	—	—	—	E	P	—	F
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	—	P
metsulfuron (Manor)	P	P	P	P	P	F-G	G	P	G	P	F	P	—	P
pinoxaden (Manuscript)	G	F	—	—	F	P-F	—	—	F-G	—	—	—	—	G-E
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	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-E	P	G	—
topramezone (Pylex)	F	E	F-G	—	F	F	—	—	—	—	P	F	—	—
trifloxysulfuron (Monument)	P	P	E	—	F-G	–	E	—	F	–	E	P	–	F
quinclorac (Drive)	E	P	P	—	F	P	P	P	P	P	P	P	–	P-F

[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.

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

Weed	Lifecycle	Amicarbazone	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	Clopyralid	Flumioxazin	florasulam + halauxifen	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	—	—	—	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	—	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	—	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	G	—	—	—	G	--	—	—	G	—	—	—	G	—	—	—	F-G	—	—
Buttercups	WA,B&P	—	F	G	F	F-G	E	E	E	—	G	G	F	—	—	G	G	G	G	E	—	—	E	—	G	E	G	G	G	G
Buttonweed, Virginia	P	—	—	F	P-F	F	F	E-F	E-F	F	G	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	—	—	—	E	—	—	E	G	F	—	G	G	—	G
Chamberbitter	SA,P	—	G-E	P	—	—	—	—	—	—	—	—	—	—	—	—	P	—	—	E	—	—	—	—	E	—	—	—	—	—
Chickweed, common	WA	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	G	G	G	E	E	E	F	G	P	G	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	—	—	E	G	F	—	G	G	—	G
Cinquefoil, common	P	—	—	E-F	E-F	E-F	E-F	E-F	E-F	—	G	—	—	—	—	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	F-G	G	G	E	E	E	—	G	G	G	G	—	G	—	—	—	F	—	E	E	—	E	—	E	G	—	G
Clover, white	P	—	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	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	E-F	G	G	G	E	E	E	—	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	—	—	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	—	E-F	E	F	E-F	E	E	E	—	—	—	—	—	—	—	—	G	—	P	—	E	—	—	—	E	—	—	—	—
Dock, broadleaf & curly	P	—	F	G	F-G	F-G	G	F-G	E-F	—	G	G	—	—	—	G	—	—	G	G-E	G	—	G	F-G	G	E	—	G	G	G
Dogfennel	P	—	—	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	—	—	—	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	—	—	—	—	—	—	E	—	—	—	—	G	G	G
Garlic, wild	P	—	P	G	P	—	E-F	E-F	E-F	—	G	—	—	—	—	G	G	—	—	G-E	—	P	G	—	G	—	—	G	G	G
Geranium, Carolina	WA	—	E	E	E-F	E	E	E	E	—	G	—	G	—	—	G	G	—	—	P-F	—	—	E	—	--	—	G	G	G	G
Groundsel	WA	—	—	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	P	E-F	E	E	E	—	G	P	—	—	—	G	—	—	—	G	—	—	G	P	—	E	E	G	—	G
Henbit	WA	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
Horseweed	WA,SA	—	E	F	—	E	—	—	G-E	—	—	G	—	—	—	—	—	G	—	G	—	F-G	—	—	E	E	—	—	—	—
Ivy, ground	P	—	—	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

Weed	Lifecycle	Amicarbazone	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	Clopyralid	Flumioxazin	florasulam + halauxifen	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
Knawel	WA	—	—	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	—	—	—	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	—	E	G	G	F	G	G	G	G
Lespedeza, annual	SA	—	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
Medic, black	A	—	—	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	—	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	—	—	—	—	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	—	E	G	G	E-F	E-F	E-F	E-F	F	G	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-E	G	—	E	F-G	—	—	—	E	G	G
Pineapple-weed	WA,SA	—	—	F	F	—	F	F	F	—	G	G	—	—	—	—	—	G	—	G	G	—	E	—	F	—	—	G	G	G
Plantains	P	—	F-P	G	G	G	E	E	E	—	G	G	—	G	F-G	—	—	G	—	G-F	—	—	G	F-G	F-G	E	E	G	G	G
Purslane, common	SA	G	G	G	F	G	G	G	E-F	—	G	—	—	—	E	—	—	—	—	G	G	—	E	G	—	—	G	G	G	G
Pusley, Florida	SA	—	–	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	—	E	G	G	F	G	G	G	G
Rocket, yellow	WA,B	—	—	F-G	F-G	F	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	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	—	—	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	F	—	G	—	—	E	F-G	F-G	G	F-G	G	—	G	G
Speedwell, corn	WA	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	—	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	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	—	P	G	G	G	E-F	E-F	E	F	G	G	—	—	—	G	G	G	G	P-F	—	—	E	G	—	G	G	G	—	G
Vetch, common	WA, SA	—	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	—	—	F-P	F-P	E-F	F-P	F	F-P	—	G	—	—	—	—	—	—	—	G	—	—	—	F-G	F	F	F-G	F-G	F-G	G	G

Weed	Lifecycle	Amicarbazone	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	Clopyralid	Flumioxazin	florasulam + halauxifen	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
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	—	—	—	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 (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
amicarbazone (0.044 to 0.175)	Xonerate 70WDG (1 to 4 oz) Xonerate 2SC (1.4 to 5.6 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 (70 WDG formulation) each or 2.8 oz/ac (2SC formulation) starting in late winter 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. Maximum use rate per season is 10 total oz/acre. Read label closely before using on tall fescue or Ky. bluegrass. Triazolone herbicide.
bispyribac-sodium (0.058 lb)	Velocity PM 3.7SC (2.25 oz)	Selective *Poa annua* and *Poa trivialis* control in overseeded ryegrass, bentgrass fairways, and tall fescue	Bermudagrass overseeded with ryegrass, Bentgrass fairways, Tall & fine fescue, Perennial ryegrass	Apply in late winter when day/night temperatures are 80/60 F in 25 to 50 gallons of water per acre. May cause short-term ryegrass chlorosis (aka, flashing). Reapply in 14 to 21 days. Ryegrass should be overseeded at $\geq$300 lb seed/acre. No surfactant or adjuvants are needed. On bentgrass fairways, apply 0.75 fl oz/ac every 14 to 21 days in spring/summer when the bentgrass is actively growing. For Poa trivialis control, apply 2.25 fl oz/acre 3 times starting in late winter. Pyrimidinyl benzoic acid family.
2,4-D Amine (0.5 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 pt)			
dicamba (0.33 to 0.5 lb) See product label.	Vanquish 4S (0.25 to 1 pt) plus others	White clover, spurges, woodsorrel, dichondra, wild onions, henbit, knotweed, lespedeza, docks, + others		Avoid drift. Effective on weeds not controlled by 2,4-D such as henbit, knotweed, clovers, lespedeza, docks, and woodsorrel, therefore, is in many 2- and 3-way mixtures. Do not apply within the root zone of ornamentals as leaching may occur. 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 cause injury to creeping bentgrass at rates greater than 0.5 lb ai/A; as little as 4 fl oz/A provides weed control. Use low rate on cool-season grasses. Benzoic acid herbicide.
dicamba (0.375 lb) + 2,4-D, MCPP, MCPA, 2,4-DP (0.5 to 0.75 lb) &/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 (0.75 fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (0.75 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 (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
carfentrazone (0.0022 to 0.031 lb)	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 broader weed control 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. On greens, adjust rate to 0.098 lb ai/A to control silvery thread moss & apply as often as every 2 weeks when temperatures ≤ 85°F. Annual bluegrass can be damaged at rates greater than 2.0 oz/A. Use NIS at 0.25% (v/v). Do not apply if bensulide has been applied within the previous 75 days.
clopyralid (0.09 to 0.5 lb) clopyralid + triclopyr (0.09-0.19 + 0.28-0.56)	Lontrel T&O 3L (0.25 to 1.33 pt) Confront 3L (1 to 2 pt)	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 >0.5-inch. Picolinic acid herbicides.
fluroxypyr (0.125 to 0.5 lb)	Spotlight 1.5L (0.66 to 2.66 pt)	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 pt)	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 lb)	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.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
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, Poa, ryegrass, fescue clumps, tropical signalgrass, dallisgrass suppression.	Bermudagrass Zoysiagrass	For dallisgrass & tropical signalgrass 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. Additional spot treatments at 0.073 oz/gallon water can be applied. Spray to wet and add ammonium sulfate (21-0-0 at 1.5 lb product/ acre to increase control. Treat no more than ¼ of the total area. 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. Add MSO or NIS at 0.25% v/v. Sulfonylurea, sulfonylaminocarbonyl triazolinone.
flumioxazin (0.375 lb)	SureGuard 4L (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. A 15-ft nontreated buffer is suggested adjacent bentgrass if the area is severely sloped &/or saturated soil is treated. BroadStar 0.25G is a granular formulation. Dicarboximide herbicide.
penoxsulam (0.01 to 0.06 lb)	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 lb 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 lb)	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)	Dismiss 4F, Spartan 4F, Surepyc 4F (0.25 to 0.75 pt)	Broadleaf weeds including dandelion, henbit, clovers, chickweed, spurges,	Bahiagrass Bentgrass Bermudagrass Buffalograss	Sulfentrazone alone is safe on most warm- and cool-season turfgrasses. When combined with imazethapyr or imazaquin, warm-season grasses only. 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

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
sulfentrazone + imazethapyr (0.29 to 0.45) sulfentrazone + imazaquin (0.36 to 0.76)	Dismiss South 4F (9.5 to 14.4 oz) Surepyc IQ 2.2L (21 to 44 fl oz)	speedwells, wild garlic and many others. Also suppresses and controls annual sedges, purple and yellow nutsedge and kyllingas	Carpetgrass Centipedegrass Fine Fescue Kentucky bluegrass Ryegrass Seashore Paspalum St. Augustinegrass Tall Fescue Zoysiagrass	to golf course tees or greens. Do not apply directly to landscape ornamental or ornamental beds. 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 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 and Surepyc IQ provide similar weed control as Dismiss with the addition of purple nutsedge but only on warm-season grasses.
sulfentrazone + quinclorac (0.75 to 1.5)	Solitaire 75WG (1 to 2 lb)	Numerous broadleaf weeds, yellow nutsedge, 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 nutsedge, 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, (0.5 to 1 lb) triclopyr +2,4-D (0.25 to 0.5) + (0.5 to 1 lb)	Turflon Ester 4L (1 to 2 pt) Turflon II Amine (1 to 2 qt) Chaser 3L (1 to 2 qt)	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.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
MSMA/DSMA/CMA (1.0 to 2.0 lb)	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. 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. 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: Not labeled in Florida; also new spot treatment restrictions elsewhere.
MSMA (1.0 lb) + metribuzin (0.125 to 0.25 lb)	Several brands + Sencor 75DF (0.16 to 0.33 lb)	Crabgrass, goosegrass, dallisgrass, nutsedge, thin paspalum		Tank mix provides better goosegrass control vs. MSMA alone. Do not apply to turf under stress, 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 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: Not for use in Florida.
MSMA (1.0 lb) + foramsulfuron (0.039 lb)	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: In Florida, the USEPA has cancelled all arsenical herbicides for turf.
metribuzin (0.25 to 0.5 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.
ethofumesate (1 to 1.5 lb)	Prograss/Poa Constrictor 4L (32 to 48 oz)	Annual bluegrass, chickweed		Provides annual bluegrass control in dormant bermudagrass overseeded with perennial ryegrass. The first application 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 1.5 lb) metsulfuron (0.02 lb) rimsulfuron (0.0075 to 0.03) foramsulfuron (0.013 to 0.039) trifloxysulfuron (0.005 to 0.015)	Kerb 3.3L (39 to 58 oz) Manor/Blade/MSM 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 encouraged 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. Treated plants do not show herbicide symptoms until air temperatures are consistently above 60F. Pronamide is no longer a Restricted Use Pesticide. Use low rates on bermudagrass golf greens. Amide and sulfonylurea herbicides.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
flazasulfuron (0.023 to 0.047 lb)	Katana 25DG (1.5 to 3.0 oz)	Broadleaf weeds, cool-season grasses, kyllinga, annual, globe & yellow nutsedges. Suppresses purple, cylindric & rice flatsedge.		Controls/suppresses kyllinga/nutsedge species as listed. Also controls most cool-season grasses and many broadleaf weeds. Labeled for bermudagrass and seashore paspalum greens plus zoysiagrass, centipedegrass, and buffalograss. Label suggests tank mixing urea fertilizer (46-0-0) at 24 to 71 lb fertilizer per acre for improved *Poa annua* control. Add a non-ionic surfactant at 0.25% v/v (1 qt/100 gal).
rimsulfuron (0.015 to 0.0625 lb)	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.
glyphosate (0.375 lb)	Roundup Pro 4L (0.75 pt)	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.
glyphosate + diquat (3.55 to 6.7 lb)	QuickPRO 76 WG (4.5 to 9 oz)			
glufosinate (0.75 lb)	Finale 1SC (3 qt); Cheetah Pro 2.34L (41 oz)			
diquat (0.25 to 0.5 lb)	Reward 2L (1 to 2 pt)			
clethodim (0.25 lb)	Envoy 0.94 EC (34 oz/a)			
metribuzin (0.25 to 0.5)	Sencor 75 Turf (0.33 to 0.67 lb)			
asulam (2.0 lb)	Asulox 3.34L (5 pt)	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 lb)	Several Brands. Read the label for rates	Many broadleaf weeds including matchweed, oxalis, pennywort,	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

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine + bentazon (0.5 to 0.75 lb)	Prompt 5L (1.8 to 2.4 pt)	Florida betony and some annual sedges.		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 (0.01 to 0.04 lb)	Manor 60DF Blade 60DF Escort 60DF MSM Turf 60DF (0.25 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 (0.125 to 0.25 lb)	Vanquish 4S (0.25 to 0.5 pt)	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 (0.125 + 0.25 to 0.5 lb)	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 year.
dicamba + 2,4-D + penoxsulam + sulfentrazone (0.27 to 0.6 lb)	Avenue South 0.8L (2.7 to 6 pt)			Also labeled in buffalograss, seashore paspalum, kikuyugrass, Ky. bluegrass, Poa annua, ryegrass, and fescue. For all major turf sites except golf greens. Two treatments allowed per season, adjuvant not needed. Use when air temperatures are <90F. Controls many broadleaf weeds as well as doveweed. Refer to label for rates on specific turfgrass species as well as tank-mixing with metsulfuron.
bromoxynil (0.375 to 0.5 lb)	Buctril 2L (1 to 2 pt)	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 lb)	Vantage 1L, Segment 1L (1.5 to 2.25 pt)	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.
clethodim (0.125 to 0.25 lb)	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.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
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.
ethofumesate (3.0 lb)	Prograss 1.5EC (2 gal)	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 1.5 pt/A and repeat at 3-week intervals. Seedlings should be at least 4 weeks old before treatment. Do not mow for 24 hr 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.
fluazifop-butyl (0.05 to 0.1 lb)	Fusilade T&O II 2EC (3 to 6 oz)	Annual grasses, bermudagrass suppression	Tall fescue, Fine fescue, Zoysiagrass	Add NIS at 0.25% v/v. Begin treatment on zoysiagrass at 3 to 4 fl oz/A in early June, repeat every 4 weeks. On tall fescue initiate in spring after bermudagrass green-up at 5 to 6 fl oz/A & 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. 8 to 16 fl oz/A can be used on naturalized fine fescue areas on golf courses. Adding triclopyr ester (Turflon Ester) at 1 pt/a may increase control but not on desirable warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.
pinoxaden (0.032 to 0.063 lb)	Manuscript 0.42L (9.6 to 19.2 oz)	Bahiagrass Crabgrass Dallisgrass Tropical Signalgrass	Bermudagrass, Zoysiagrass, St. Augustinegrass (sod)	For golf (less greens), commercial & residential areas, sod, sports fields, and non-crop areas. A total of 19.2 fl oz is allowed yearly per acre. For signalgrass control (and resistance management), also incorporate Dismiss South, Monument, Revolver, Tribute Total &/or Xonerate. For St. Augustinegrass, use only in sod. Refer to label for spot treatment instructions.
quinclorac (0.75 lb)	Drive 75 DF (1 lb)	Crabgrass, signalgrass, torpedograss, barnyardgrass, foxtail,	Annual bluegrass Annual ryegrass Bentgrass fairways	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

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
	Drive XLR8 1.5L (0.5 gal)	kikuyugrass, broadleaf weeds such as pennywort, speedwells, dandelion, black medic, white clover, violets	Buffalograss Common bermuda Kentucky bluegrass Perennial ryegrass Seashore paspalum Tall fescue Zoysiagrass	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 pt/a) or methylated seed oil (1.5 pt/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 (0.25 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, lawns, and commercial properties. Tenacity 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 PRE 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. For goosegrass control: creeping bentgrass at 0.25 oz/acre; bermudagrass & seashore paspalum 0.5 to 0.75 fl oz/a + MSO. Short term (2 to 4 week) 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 (0.5 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 (0.75 fl oz/1000 sq.ft.) and MCPP-4 amine (0.75 fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (0.75 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.
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 application. 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.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
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 lb)	Tupersan 50WP (22 to 44 lb)	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 1.5L + 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.
ethofumesate (0.5 to 1.0 lb)	Prograss 1.5L (43 to 85 oz) Prograss/Poa Constrictor 4L (16 to 32 oz)	Annual bluegrass (*Poa annua*)	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. The 4SC formulations is being phased out. 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 hr 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.

POSTEMERGENCE HERBICIDE SAFENER

Common Name (lb ai/acre)	Trade Name (product rate/acre)	Weeds Controlled	Turfgrass Use	Comments
Metcamifen + trifloxysulfuron (0.26 lb)	Recognition 20WDG (1.29 to 1.95 oz/ac)	Those normally controlled by trifloxysulfuron such as sedges and kyllinga species.	St. Augustinegrass, Zoysiagrass	Recognition is a combination of a herbicide safener (metcamifen) + trifloxysulfuron (Monument) and can be used on zoysiagrass (all types) and St. Augustinegrass. High rate (1.95 oz/ac) intended for golf greens, lower rate (1.29 oz/ac) for other turf areas. Can also add fluazifop (Fusilade T&O), clethodim (Envoy, Clethodim), quinclorac (Drive) or triclopyr ester (Turflon Ester) to these turfgrasses safely with Recognition. Recognition doesn't safen soil application, thus, if Fusilade is added to it, ~2 weeks soil residual often occurs. Recognition also safens crabgrass (*Digitaria* spp.) tolerance.

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

COMMON NAME (lb ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
bentazon (1 lb)	Basagran T&O 4L (2 pt) Lescogran 4L (2 pt)	Yellow nutsedge, globe sedge, annual sedge and many annual broadleaf weeds	Annual bluegrass Bahiagrass Bermudagrass Buffalograss Centipedegrass Creeping bentgrass Fine fescue Kentucky bluegrass Ryegrass St. Augustinegrass Tall fescue Zoysiagrass	Also labeled for bentgrass fairways, carpetgrass & buffalograss. 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 (0.5 gal/100 gal). Nutsedges should be actively growing when treated. Spot treat with 0.9 grams Sedgehammer 75WP + 3 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.
flazasulfuron (0.023 to 0.047 lb)	Katana 25WP (1.5 to 3.0 oz)	Kyllinga species, annual, globe & yellow nutsedge. Suppresses purple, cylindric & rice flatsedge	Bermudagrass, Buffalograss, Centipedegrass, Seashore paspalum, Zoysiagrass	Controls/suppresses kyllinga/nutsedge species as listed. Also controls most cool-season grasses and many broadleaf weeds. Labeled for bermudagrass and seashore paspalum greens. Label suggests tank mixing urea fertilizer (46-0-0) at 24 to 71 lb fertilizer per acre for improved *Poa annua* control. Add a non-ionic surfactant at 0.25% v/v (1 qt/100 gal).
MSMA (2.0 lb)	Several brands	Yellow nutsedge, annual (water) sedge	Bermudagrass Zoysiagrass	Can also be used on annual & Ky. bluegrasses. 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 while trifloxysulfuron can also be used on buffalograss. 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 pt)	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 2 pt/a during December followed with 0.5 to 1.5 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 lb)	Image 1.5LC (2 pt) + Several Brands	Most sedges and kyllinga species.	Bermudagrass	Same as for MSMA and imazaquin. Repeat applications may be required as weeds mature.
imazaquin + sulfentrazone (0.29 to 0.75 lb)	Surepyc IQ 2.2L (22 to 44 oz)	Sedges & Kyllinga sp + many broadleaves	Bermudagrass Centipedegrass St. Augustinegrass	Lawns, golf courses, athletic fields, parks, sod. Do not use on golf course greens or tees, desirable cool-season turf, or directly to landscape ornamentals or ornamental beds. Do not use with 4 weeks of reseeding, overseeding, sprigging or

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

	Sulfen So. 4L (9.6 to 14.4 fl oz)		Zoysiagrass	during spring transition. Split applications at 22 oz/ac (3X) or 32 oz/ac (2X) 35 days apart are suggested. Add NIS at 0.25% v/v. Aryl-triazinone + imidazolinone
imazosulfuron (0.38 to 0.66 lb)	Celero 75WDG (8 to 14 oz)	Most sedges and kyllinga species + some broadleaves	Bermudagrass, Bentgrass, Centipdegrass, 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 12 oz/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. Dismiss NXT/Spartan Charge reduces the number of viable yellow nutsedge tubers. Several additional combination products containing sulfentrazone are available.
carfentrazone + sulfentrazone (see label)	Dismiss NXT (5 to 15) Spartan Charge 4L (5 to 12 oz - sod only)			
sulfentrazone + imazethapyr (0.29 to 0.45 lb)	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, desirable cool-season turf, or directly to landscape ornamentals or ornamental beds. Split applications are suggested 35 days apart at 9.5 oz fb 4.9 oz/ac or 7.2 oz fb 7.2 oz/ac. Aryl-triazinone + imidazolinone herbicide.
pyrimisulfan (0.044 to 0.061 lb)	Vexis 0.00025G (2 lb/500 sq.ft.) Arkon 0.103L (3.4 to 4.7 pt)	Sedges, kyllingas, selective broadleaves	Most warm- and cool-season turfgrasses	Vexis G is a granular pyrimisulfan formulation while Arkon is a liquid. Vexis is used for spot treatments while Arkon can be broadcasted. A repeat application can be made 30 days after the initial, not to exceed 7 pt/ac/yr. Pyrimidinyl(thio)benzoate.

[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; lb/acre x 0.02296 = lb/1000 ft^2.

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

	Sedge Control					Turf Tolerance (excluding greens)												
Herbicide (trade names)[1]	Annual Sedge	Purple Nutsedge	Yellow Nutsedge	Annual Kyllinga	Perennial Kyllinga	Bahiagrass	Bentgrass	Bermudagrass	Buffalograss	Centipedegrass	Fine Fescue	Kikuyurass	Ky. Bluegrass	Perennial Ryegrass	Seashore Paspalum	St. Augustinegrass	Tall Fescue	Zoysiagrass
Preemergence Control																		
Dimethenamid (Tower)	G[2]	F-G	G	G	F-G	S	S	S	S	S	S	S	S	S	S	S	S	S
Metolachlor (Pennant Magnum)	G	P	G	F-G	P	S	NR	S[3]	NR	S	NR	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	S	NR	S	S	NR	S	S	S
Flazasulfuron (Katana)	G	F	F-G	G	G	NR	NR	S	S	I-S	NR	NR	NR	NR	I	NR	NR	S
Imazaquin (Image)	G	G	F	G	G	NR	NR	I-S	NR	I	NR	NR	NR	NR	NR	I	NR	S
Imazosulfuron (Celero)	G	G-E	G-E	G	F	NR	S	S	NR	S	S	NR	S	S	NR	S	S	S
Halosulfuron (Sedgehammer)	G	G-E	G-E	G	F-G	S	S	S	S	S	S	S	S	S	S	S	S	S
Mesotrione (Tenacity, TRIONE)	P	P	G	P	P	NR	NR	I	S-I	S-I	S-I	NR	S	S-I	I	S-I	S-I	NR
MSMA/DSMA/CMA	G	P-F	F	G	G	NR	I	S-I	I	NR	I	NR	S-I	S-I	NR	NR	I-S	S-I
Image + MSMA/DSMA	G	G	G	G	G	NR	NR	S-I	NR	NR	NR	NR	NR	NR	NR	NR	NR	S-I
Pyrimisulfan (Vexis/Arkon)	G	G	G	G	G	NR	S	S	S	S	S	NR	S	S	S-I	S	S	S
Sulfentrazone (Dismiss)	G	P-F	F	F	F	S-I	S	S	S	S	S	S	S	S	S	S-I	S-I	S-I
Sulfentrazone + imazethapyr (Dismiss South)	G	G	G	G	G	S-I	NR	S-I	S	S-I	NR	S	NR	NR	NR	NR	NR	S-I
Sulfosulfuron (Certainty)	G	G	G	G	G	S-I	NR	S	S	S	NR	S	NR	NR	S-I	S-I	NR	S
Trifloxysulfuron (Monument)	G	G	G	G	G	S-I	NR	S	S-I	NR	NR	NR	NR	NR	NR	I	NR	S

[1]Repeat applications are necessary for complete control from all herbicides.

[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.

MANAGING HERBICIDE RESISTANT WEEDS

Bert McCarty

Herbicide resistant weeds in turf, such as *Poa annua*, spurges, goosegrass, nutsedges, kyllinga, 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.

Listing of currently used herbicides in Turf and Ornamentals based on their application timing(s) and mechanism of action.

WSSA*	Mechanism of Action	Active Ingredient (Trade Name Example)*
1	Acetyl CoA Carboxylase (ACCase) enzyme (Lipid Biosynthesis) Inhibition	Clethodim (Envoy) Diclofop (Illoxan) Fenoxaprop-ethyl (Acclaim Extra) Fluazifop-P (Fusilade II) Metamifop (na) Pinoxaden (Manuscript) Sethoxydim (Vantage) Quizalofop-P-ethyl (Assure II)
2	Acetolactate Synthase (ALS) enzyme [aka, Acetohydroxyacid Synthase (AHAS)] Inhibition	Bispyribac-sodium (Velocity) Chlorsulfuron (Corsair) Flazasulfuron (Katana) Florasulam (Relzar component) Foramsulfuron (Revolver) Halauxifen-methyl (mixture component) Halosulfuron (Sedgehammer) Imazamox (Raptor) Imazapic (Plateau) Imazapyr (Arsenal) Imazethapyr (mixture component) Imazaquin (Image) Imazosulfuron (Celero) Metsulfuron (Manor, MSM, Blade) Penoxsulam (Aethon component) Pyrimisulfan (Aethon component, Vexis, Arkon) Rimsulfuron (TranXit) Sulfometuron (Oust) Sulfosulfuron (Certainty) Thiencarbazone-methyl (Tribute Total component) Trifloxysulfuron (Monument)
3	Mitotic (microtubule assembly) inhibition	Benefin (Balan) Dithiopyr (Dimension) Oryzalin (Surflan)

WSSA*	Mechanism of Action	Active Ingredient (Trade Name Example)*
		Pendimethalin (Pendulum) Prodiamine (Barricade) Pronamide (Kerb) Trifluralin (Treflan)
4	Synthetic auxin inhibitors	2,4-D, dicamba, MCPP, 2,4-DP, MCPA (many) Aminocyclopyrachlor (Imprelis) Aminopyralid (Milestone) Clopyralid (Confront) Fluroxypyr (Spotlight) Halauxifen-methyl (mixture component) Quinclorac (broadleaves)(Drive) Triclopyr (Turflon)
5	Photosystem II inhibition (Serine 264 Binders)	Amicarbazone (Xonerate) Atrazine (Aatrex) Cumyluron (Samurai) Diuron (Karmex) Hexazinone (Velpar) Metribuzin (Sencor) Simazine (Princep) Siduron (Tupersan) Tebuthiuron (Spike) Terbuthylazine (Gardoprim)
6	Photosystem II inhibition (Histidine 215 Binders)	Bentazon (Basagran) Bromoxynil (Buctril)
9	Enolpyruvyl Shikimate-3 Phosphate (EPSP) synthase inhibition	Glyphosate (Roundup)
10	Glutamine synthetase inhibition	Glufosinate (Finale, Cheetah Pro)
12	Phytoene Desaturase inhibition	Fluridon (Sonar) Norflurazon (Predict)
14	Protoporphyrinogen oxidase (PPO or Protox) inhibition	Carfentrazone-ethyl (Quicksilver) Flumioxazin (SureGuard, StayGuard) Oxadiazon (Ronstar) Oxyfluorfen (Goal) Pyraflufen-ethyl (Octane) Sulfentrazone (Dismiss)
15	Very Long Chain Fatty Acid Biosynthesis inhibition	Ethofumesate (Prograss) Dimethenamid (Tower) Metolachlor (Pennant) Pethoxamid (StriCore)
17	Nucleic Acid inhibition (also listed as Group 0)	MSMA, DSMA
18	Dihydropteroate (DHP) synthase inhibition	Asulam (Asulox)
22	Photosystem I (Lipid peroxidation) inhibition/electron diverters	Diquat (Reward)

WSSA*	Mechanism of Action	Active Ingredient (Trade Name Example)*
		Paraquat (Gramoxone)
25, 26	Cell Membrane Disruptors	Dilute Sulfuric Acid, Herbicidal Oils
27	Carotenoid biosynthesis (HPPD or 4-hydroxyphenyl-pyruvate dioxygenase) inhibition	Mesotrione (Tenacity) Topramezone (Pylex)
29	Cellulose biosynthesis inhibition	Indaziflam (Specticle) Isoxaben (Gallery) Quinclorac (grasses) (Drive)
30	Tyrosine Aminotransferase or Fatty Acid Thioesterase Inhibition (cell wall biosynthesis inhibitor)	Methiozolin (PoaCure)
31	Serine-threonine Protein Phosphate inhibition	Endothall (Aquatrol)
0	Unclassified/Unknown (Nucleic Acid inhibition are also classified here)	Bensulide (Bensumec) Fosamine (Krenite) – possibly a mitotic inhibitor Napropamide (Devrinol)

*WSSA = Weed Science Society of America Mechanism of Action Numbering system.
**Additional trade names are available for many products.

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 and prohexadione-Ca are foliar absorbed Type II PGRs and systemically translocated to the site of activity.

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 important. Applications made after seedhead emergence may not be effective. For bahiagrass, mow 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.

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	Golf Greens	Seedhead suppression	
Ethephon (Proxy)	—	—	—	**Y**	**Y**	**Y**	—	**Y**	—	—	**Y**		—	**Y**	—	Y	Promotes ethylene which reduces cell elongation
Flurprimidol (Cutless)	—	**Y**	—	**Y**	—	**Y**	—	**Y**	—	**Y**	—	**Y**	**Y**	—	**Y**	N	Type II early GA inhibitor of cell elongation
Gibberellic acid (RyzUp)	—	**Y**	—	—	—	—	—	—	—	—	—	—	**Y**	**Y**	—	N	Promotes gibberellin synthesis
Imazapic (Plateau)	**Y**	**Y**	**Y**	—	—	**Y**	—	—	—	—	**Y**	—	**Y**	**Y**	**N**	**Y**	Inhibits branch-chain (ALS) amino acids
Indolebutyric acid + gibberellic acid	—	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	—	**Y**	**Y**	**Y**	—	**Y**	**Y**	N	Enhance root growth & plant vigor
Maleic hydrazide (Slo Gro)	**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**	**P**	Type II early GA inhibitor of cell elongation
Trinexapac-ethyl (Primo)	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	—	**Y**	**Y**	**P**	Type II late GA inhibitor of cell elongation
Prohexadione-Ca (Anuew 27.5WP)	—	**Y**	—	**Y**	—	**Y**	—	**Y**	—	—	—	—	—	**Y**	**Y**	**P**	Type II GA inhibitor of cell elongation

Y = Yes; **P** = Partial

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

Characteristics of Various Plant growth Regulators for Turfgrass Management

Common names	PGR trade name	Absorption site	Comments
Ethephon	Proxy	Foliar	•Often used with trinexapac-ethyl for *Poa* seedhead suppression in bentgrass golf greens. Apply in spring at *Poa* 'boot stage' to suppress seedheads. Excessive use may cause stem elongation, followed by scalping.
Flurprimidol	Cutless	Root	•Water required for activation. For *Poa* seedhead suppression, multiple fall & spring applications needed to suppress *Poa* when growing more rapidly than bentgrass. Treated bentgrass may turn bluish-green while Poa may develop yellow or brownish-green. Do not overseed within 2 weeks of application. Avoid using with DMI fungicides or GA biostimulant, as these may enhance/reduce effects and cause turf chlorosis.
Glyphosate	Roundup Pro, others	Foliar	•Used on low-maintenance turfgrasses for seedhead/growth suppression.
Imazapic	Plateau 2L	Foliar & root	•Used mainly on low-maintenance turfgrasses for seedhead/growth suppression. It has a fine bermudagrass label, though, common bermudagrass generally is more tolerant as is zoysiagrass. Tolerance also is very rate dependent. Inhibits branch-chain amino acid (ALS) biosynthesis.
Paclobutrazol	Trimmit/Turf Enhancer/TGR	Root	•Water required for activation. For *Poa* seedhead suppression. Treat only actively growing Poa. Stop use within 30 days of anticipated hot or cold temperatures. Treated bentgrass may turn bluish-green while Poa may develop yellow or brownish-green. Do not overseed within 4 to 8 weeks of application. Avoid using with GA biostimulant, as these may reduce its effects and cause turf chlorosis. This program encourages a gradual transition from Poa to bentgrass & will require repeat applications over several years.
Prohexadione-Ca	Anuew	Foliar	•Reduces clippings, improves putting surfaces & ball roll distances similarly to trinexapac-ethyl but lasts longer. Quick acting. Reapplications based on 280 to 350 Growing Degree Day model.
Sulfometuron	Oust	Foliar & root	•Use is restricted to low-maintenance turfgrasses. Inhibits amino acid biosynthesis.
Trinexapac-ethyl*	Primo, others	Foliar	•Often tank-mixed with other PGRs to improve turf quality. Improves Poa's ability to tolerate summer stress. Improves turf quality when grown in shade and enhances turf color and density. Rainfast within 1 hour. Improves putting surfaces & ball roll distances.
		Chemicals for growth and color promotion	
Gibberellic acid	Gibgrow, ProGibb, RyzUp 4% active solution	Foliar	•Apply 10 grams ai/acre (10 fl oz/a or 0.23 fl oz/1,000 ft^2) weekly or 25 grams ai/acre biweekly in 25 to 100 GPA (234 to 935 L/ha) to promote growth, prevent discoloration (e.g., purpling) during periods of cold stress on bermudagrasses such as Tifdwarf or Tifgreen, or to reverse effects of GA-inhibiting PGRs. Do not apply when night temperatures exceed 65°F (18 C) or on cool-season turf.

*Trinexapac-ethyl is commonly mixed with flurprimidol or paclobutrazole to take advantage of two sites of absorption, thus, more rapid growth suppression with less turf discoloration and bronzing. Combinations also provide more consistent foliar growth suppression and decreases clipping production.

SEEDHEAD AND PLANT GROWTH SUPPRESSION

Bert McCarty

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

Turf Use	Chemical Name (rate, lb 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, Ethephon 2SL (1.7 gal/A or 5 fl oz/1000 ft^2)	Foliar absorbed. Seven to 10 days are necessary for activity. Repeat applications are 2 to 4 weeks following the first for perennial ryegrass. A spreader/sticker is not needed. Tank mixing with trinexapac-ethyl enhances turf response and reduces yellowing from Proxy/Ethephon when applied alone.
	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 (0.1 to 0.16)	Trimmit/Turf Enhancer 2SC (6.4 to 10 oz/A)	Root absorbed. Economical. Typically, 8 fl oz/A is applied on 2 to 4 week intervals. Apply 0.25 inch of water within 24 hours after application to move onto soil surface. Apply in 2 to 3 gallons of water per 1,000 ft^2.
	paclobutrazol + flurprimidol + trinexapac-ethyl (0.14 to 0.28)	Musketeer 1L (18 to 36 oz/acre)	For turf growth suppression, make the initial spring application at 18 to 30 oz/a with repeat applications 2 to 4 weeks later at 18 to 36 oz/a (depending on rate used). Provides partial seedhead suppression.
	prohexadione-Ca (0.14 to 0.28)	Anuew 27.5 WP (8 to 16 oz/A)	Foliar uptake. Apply in 1 to 2 gal/1,000 ft^2, add NIS, and wait 4-hr before irrigating and 1-day before mowing. This product has provided good Poa suppression in bentgrass fairways/roughs.
Turfgrass Clipping Management/Turfgrass Enhancement	flurprimidol (0.375 to 1.5)	Cutless 50 WP (0.75 to 3.5 lb to 200 gal water or 0.28 to 1.3 oz/1,000 ft^2) Cutless MEC 1.3L (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 0.5-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.
	imazapic (0.0156 to 0.094)	Plateau 2L (1 to 6 oz/A)	Foliar (mostly) and root uptake. Used on hybrid and common bermudagrass (2 to 4 oz/a), centipedegrass, Ky. bluegrass, tall fescue and zoysiagrass for growth suppression (low rates) or control (high rates). Read and follow label directions before use. Imidazolinone family.

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

Turf Use	Chemical Name (rate, lb ai/acre)	Trade Names (rate, product)	Remarks
	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.
	prohexadione-Ca (0.031 to 0.76)	Anuew 27.5 WP (1.8 to 44 oz/A)	Foliar uptake for managing growth of bermudagrass, bentgrass, Ky. bluegrass, and perennial ryegrass grown for all turf areas. Rates include: bentgrass greens at 1.8 to 7.25 oz/acre; bermudagrass at 29.1 to 43.6 oz/acre; bluegrass/ryegrass fairways/roughs at 4.5 to 29.1 oz/acre. Application intervals: 2 to 4 weeks for fairways/roughs; 1 to 2 weeks for greens/tees. Apply in 1 to 2 gal/1,000 ft^2, add NIS, and wait 4-hr before irrigating and 1-day before mowing.
	paclobutrazol (0.5 to 1)	TGR Turf Enhancer 50WP (1 to 1.5 lb/43 to 100 gal) Trimmit 2SC (1 to 2 gal/A)	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 (0.06 to 0.71)	Legacy 1.52MEC (5 to 30 oz/A) Edgeless 1.51 L (30 to 60 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.
Poa annua var. *reptans* (perennial biotype) suppression & conversion in Bentgrass Golf Greens	paclobutrazol (0.375)	Turf Enhancer 50WP (0.75 lb/acre or 0.28 oz/1000ft^2) Trimmit/Turf Enhancer 2SC (24 oz/acre or 0.55 fl.oz./1000$ft^{2)}$	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) is applied 2 weeks following each paclobutrazol application. 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 lb)	Proxy 2SL, Ethephon 2SL (1.7 gal/A, 5 fl oz/1,000 ft^2)	Make initial application before seedheads emerge. Repeat applications are needed every 10 to 21 days during seedhead emergence. Tank mix with trinexapac-ethyl at 3 to 5 oz/A for improved turfgrass quality.
	flurprimidol (0.125 to 0.5)	Cutless 50W (0.25 to 0.5 lb/A) Cutless MEC 1.3L (6 to 24 fl oz/A)	Root absorbed. Repeat at 2 to 4-week intervals with the final application 8 weeks before winter dormancy or summer stress. Delay reseeding for 2 weeks after application. Provides partial seedhead suppression. Use caution with overspray onto bermudagrass collars during spring greenup as overregulation can occur.

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

Turf Use	Chemical Name (rate, lb ai/acre)	Trade Names (rate, product)	Remarks
	flurprimidol + trinexapac-ethyl (0.04 + 0.02 to 0.09 + 0.04)	Legacy 1.52 MEC (5 to 10 oz/A)	Apply in late fall and early spring at 5 to 10 oz/A and repeat in 2- to 4-week intervals. Use lower rates on Poa dominant (>50%) greens. This program is designed as gradual transition or conversion from Poa to bentgrass over several years. Provides partial seedhead suppression. Use caution with overspray onto bermudagrass collars during spring greenup as overregulation can occur.
	paclobutrazol + flurprimidol + trinexapac-ethyl (0.10 to 0.17 lb)	Musketeer 1L (12 to 22 oz/A)	Use lower rates if Poa annua population is >50%. Treatment interval are 2- to 4-weeks apart. Begin in fall & stop within 4 weeks of inactive grass growth. Resume in spring. Provides partial seedhead suppression. Use caution with overspray onto bermudagrass collars during spring greenup as overregulation can occur.
	prohexadione-Ca (0.26 to 0.52)	Anuew 27.5 WP (7.5 to 15 oz/A)	Foliar uptake. Apply in 1 to 2 gal/1,000 ft^2, add NIS, and wait 4-hr before irrigating and 1-day before mowing.
Poa annua Suppression in *Poa trivialis* Overseeding	ethephon (3.4 lb)	Proxy 2SL, Ethephon 2SL (1.7 gal/A, 5 fl oz/1,000 ft^2)	Make initial application before seedheads emerge. Repeat applications are needed every 10 to 21 days during seedhead emergence. Tank mix with trinexapac-ethyl at 3 to 5 oz/A for improved turfgrass quality. Some damage/yellowing/thinning to *Poa trivialis* may occur if applied during prolonged cold temperatures.
Extending the Life of Painted Lines on Sports Fields	trinexapac-ethyl	Primo MAXX 1EC (1 oz/gallon paint) Primo 25 WSB (0.5 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 ft^2 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, 0.23 fl oz/1,000 ft^2)	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; lb/acre x 0.02296 = lb/1,000 ft^2.

HERBICIDE AND PGR COMMON AND TRADE NAMES

Bert McCarty

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Amicarbazone	• Xonerate 70WDG, 2SC
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, NativeKlean 3.74L
Aminopyralid + metsulfuron	• Opensight
Aminopyralid + triclopyr amine	• Milestone VM 2L
Ammoniated soap of fatty acids	• Herbicidal Soap, Quick-fire
Ammonium nonanoate	• Racer
Asulam	• Asulox 3.34L, Asulam 3.3L
Atrazine	• AAtrex, Atrazine Plus, Aatrex 90DF, Atrazine 4L, Bonus S, Purge II, 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	• Crabgrass Preventer 0.92%, Team 2G, Team Pro
Bensulide	• Bensumec 4L, Betamec, Betasan, Lescosan, Pre-San 12.5 & 7 G, Squelch, Weedgrass Preventer, + 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	• Regiment 80WP, Velocity PM 3.7SC
Bromoxynil	• Buctril 2L, Broclean, Brominal 4L, Bromox 2E, Moxy 2E
Bromoxynil + MCPA	• Bison Advanced
Cacodylic Acid	• Montar, Weed Ender
Capric acid + caprylic acid	• Homeplate 80%

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Carfentrazone	• ADDIT 1.9L, Aim, Shark, Quicksilver T&O 1.9 L,
Clopyralid + 2,4-D + dicamba	• Millennium Ultra^2 3.56 L
Clopyralid + 2,4-D + triclopyr	• Confront 3, Momentum,
Carfentrazone + 2,4-D + dicamba + MCPP	• Speedzone 2.2L, Speedzone Southern 0.81L, Speedzone Northern and Bermuda 2.2L,
Carfentrazone + dicamba + MCPA + MCPP	• Power Zone,
Carfentrazone + quinclorac	• Square One 70WDG
Carfentrazone + sulfentrazone	• Dismiss NXT 3.5L, Spartan Charge 3.5L, Sulfen 10 NX
Chlorsulfuron	• Chlorsulfuron 75DF, Corsair 75DF, Telar 75DG
Chlorsulfuron + metsulfuron	• Cimarron Plus 63WDG
Clethodim	• Clethodim 2EC, Envoy 0.94 EC
Clopyralid	• Clean Slate, Lontrel T&O 3L, Stinger 3L, Transline 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
Cumyluron	• Samurai
Cytokinin	• Agriplex PGR for T&O
2,4-D	• 2,4-D Amine 4 & Ester, 2,4-D LV4, AM-40, Barrage HF, Clean Amine, Dacamine, Dymec, Esteron 638, Hardball, Lesco A-4D, Saber, Savana, Weedar 64, Weedone LV4, + others
2,4-D (choline salt) + fluroxypyr + halauxifen	• GameOn 3.3L
2,4-D + dicamba	• Banvel 2,4-D, Four Power Plus, Ranger Star 3.87L, 81 Selective Weedkiller, Triple D Lawn Weed Killer
2,4-D + dicamba + fluroxypyr	• Elliptical, Escalade 4.4L, Escalade2 4L, Excursion 2 4L
2,4-D + dicamba + MCPP + MCPA and/or 2,4-DP	• 2 Plus 2, 33-Plus, 3D 3.3L, Bentgrass Selective Weed Killer, Broadleaf Trimec, Dissolve, Eliminate DG|LO, Endrun 3.22L, Formula II, MECAmine-D, Strike 3, Threesome, Three-Way Selective, Trex-San, Triad Select 3.23L, Triamine 3.9L, TriEster, Trimec 899|992|1000, Trimec Bentgrass Formula, Trimec Classic 2.72L, Trimec Southern, Triplet LO|Hi-D|SF 3.23L, Triplet, TruPower 2|3, Vessel 3.22L, Weed-B-Gon, Weed-B-Gon for Southern Lawns, + others
2,4-D + dicamba + MCPA + sulfentrazone	• Terradex Quick Strike 2.18L; Triad SFZ Select 2.18L
2,4-D + dicamba + MCPA + triclopyr	• Terradex Power Premix 3.86L; Triad T Select 3.86L
2,4-D + dicamba + MCPP + MSMA	• Quadmec 2.64L, Trimec Plus 2.64L
2,4-D + dicamba + MCPP + pyraflufen	• 4-Speed 3.1L, RedZone 2
2,4-D + dicamba + MCPP + sulfentrazone	• Surge 2.18L, SureZone 2L
2,4-D + dicamba + penoxsulam + sulfentrazone	• Avenue South 0.8EC

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
2,4-D + dicamba + quinclorac	• Momentum Q, 2DQ, 3.86L, Terradex Crabgrass & Broadleaf 1.875L; Triad QC Select 1.875L, Trimec Crabgrass Plus Lawn Weed Killer, Quincept 1.875L,
2,4-D + dicamba + sulfentrazone + quinclorac	• Q4 Plus 1.8L
2,4-D + dicamba + sulfentrazone + triclopyr	• Triad TZ Select 2.51L, T-Zone SE 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, Fluid Broadleaf Weed Control, Patron 170, Turf D + DP, Turf Weed & Brushy Control, Weedone DPC Ester & Amine + others
2,4-D + dicamba + dichlorprop (2,4-DP)	• Super Trimec, Brushmaster
2,4-D + dichlorprop (2,4-DP) + fluroxypyr	• Strike Three Ultra 2
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 + flumioxazin + fluroxypyr + triclopyr	• SurePower 2.68L
2,4-D + fluroxypyr + triclopyr	• Momentum FX^2 2.8L
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
2,4-D + picloram	• Pathway
2,4-D + quinclorac + sulfentrazone + triclopyr	• Allstar 1.91L
2,4-D TIPA + dicamba + fluroxypyr	• Escalade Low Odor 4.4L
2,4-D TIPA + dicamba + MCPP	• Triplet Low Odor
2,4-D + triclopyr	• Aquasweep, Chaser 3L Ester, Chaser 2 Amine, Crossbow 3L Ester, Crossroad 3L, Crosswood, Turflon II Amine
2,4-DP + fluroxypyr + MCPA	• Chaser Ultra 2
2,4-DP + MCPA + MCPP	• Triamine II, Tri-Ester II
Dazomet	• Basamid G
DCPA	• Dacthal W-75 WP, Dacthal 6F
Dicamba	• Banvel 4S, Bentgrass Selective, Clarity, Clash, Cruise Control, Diablo, Dicamba DMA Salt 4L,K-O-G Weed Control, Oracle, Sterling Blue, Vanquish 4 L, Vision, + others
Dicamba + diflufenzopyr	• Distinct 0.7L, Overdrive 70WG
Dicamba + fenoxaprop + fluroxypyr	• LastCall 0.75L
Dicamba + fluroxypyr + halauxifen-methyl	• Switchblade
Dicamba + fluroxypyr + MCPA	• ChangeUp 4.8L
Dicamba + halosulfuron	• Yukon
Dicamba + iodosulfuron + thiencarbazone	• Celsius 68WDG

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Dicamba + MCPA + MCPP	• Encore DSC, Tri-Power Dry, Tri-Power Selective, Trimec Encore DSC, Triplet SF
Dicamba + MCPA + triclopyr	• Clover Power, CoolPower 3.6L, Eliminate, Three-Way Ester II, Horsepower 4.56 lb/gal, Spurge Power
Dicamba + MCPP + triclopyr	• 3-Way Ester II
Dicamba + MCPP + quinclorac	• OneTime 2.45L
Dicamba + mesotrione + triclopyr	• Acuvis 3.53L; Sublime 3.53L
Dichlobenil	• Barrier 4G, Casoron 4G
Diclofop	• Illoxan 3EC
Dikegulac-sodium	• Atrimmec1.67L, Augeo 1.67L
Dimethenamid	• Outlook 6L, Tower 6L
Dimethenamid + pendimethalin	• FreeHand 1.75G
Diquat	• Aquatate, Aquatrim II, Diquat SPC 2L, Redwing, Reward 2LS, Solera Diquat, Tsunami DQ, Vegetrol, Watrol, WeedPlex Pro,
Diquat + glyphosate	• Prosecutor Swift Acting, QuikPRO, Razor Burn 3.1L
Diquat + glyphosate + indaziflam	• Specticle Total 1.95L
Dithiopyr	• CGC 40, Crab and Spurge Preventer, Dimension 1L, Dimension 270-G, Dimension Ultra 40WSP, Dithiopyr 40WSB, Lifeguard,
Dithiopyr + oxadiazon	• SuperStar
Diuron	• Diuron, Karmex
Diuron + imazapyr	• Sahara DG
DSMA	• Ansar, DSMA Liquid, DSMA 4, Methar 30, Namate
Ethephon	• Cardinal, Ethephon 2, ProTrim, Proxy 2L, Verve
Ethofumesate	• Etho 4L, Poa Constrictor 4L, Prograss 1.5L/4.0SC, Thrasher
Fenarimol	• Patchwork 0.78G, Rubigan 1AS
Fenoxaprop	• Acclaim Extra 0.57L, Whip 360
Flazasulfuron	• Katana 25WG
Florasulam	• Defendor 0.417SC
Florasulam + halauxifen	• Relzar 0.4L
Fluazifop	• Fusilade II T&O 2L, Ornamec 170, Ornamec Over-The-Top
Flucarbazone	• Align 70WDG, Everest
Flumioxazin	• BroadStar 0.25G, Clipper 4L/51WDG, Flumioxazin 51WDG Select, Payload 51WDG, StayGuard G, SureGuard 4L,
Fluroxypyr	• Fluroxypyr 2.8L, Spotlight 1.5L, Vista 1.5L, Vista XRT 2.8L
Fluroxypyr + MCPA + triclopyr	• Battleship III
Fluroxypyr + MCPP	• Bastion T

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
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 + iodosulfuron-methyl + thiencarbazone-methyl	• Derigo 36.4WDG
Foramsulfuron + halosulfuron + thiencarbazone-methyl	• Tribute Total 60.5WDG
Fosamine	• Krenite 4S
Gibberellic Acid	• RyzUp, ProGibb T&O,
Gibberellic Acid + indolebutyric acid	• PGR IV
Glufosinate	• Cheetah Pro 2.34L, Finale 1L, Ignite, Interline 2.34L, Liberty 1.76L, Surmise Pro 2.34L, X-Out 2.34L
Glyphosate	• Accord 4L, AquaNeat, Clear-Out 41 Plus, Departure, Fireball 1.55L (acid), Gly-Flo, Glyfos, Glyphomate 41 (3.8L), Glypro, Kleenup Pro, Pronto, Prosecutor, Razor Pro, Refuge, Rodeo 5.4L, Roundup Pro 4L, Roundup ProDry, Showdown, Touchdown Pro, Trailblazer, WeatherMax, Weed Wrangler + others
Glyphosate + imazapic	• Journey 2.25L
Glyphosate + imazapyr	• Pronto Vegetation Killer 0.36L
Glyphosate + prodiamine	• ProDeuce 4.75L
Halosulfuron	• Halo 75WDG, Manage 75WP, Permit 75WP, Profine 75WP, Prosedge 75WP, Sandea 75WP, Sedgehammer 75WP, Sempra 75WP,
Halosulfuron + imazaquin	• Surepyc IQ
Halosulfuron + iodosulfuron + thiencarbazone	• Celsius XTRA 15WDG
Halosulfuron + mesotrione + quinclorac	• Linchpin
Halosulfuron + sulfentrazone	• Surepyc HALO
Hexazinone	• Velpar 2L
Imazamox	• Imazacast 1L, Raptor 1L
Imazapic	• Impose 2L, Panoramic 2SL, Plateau 2L
Imazapyr	• Arsenal 2S, Arsenal Powerline 2L, Arsenal Applicators Concentrate 4L, Chopper, Habitat, Stalker
Imazaquin	• Image 1.5L, 70DF, Scepter T&O 70WDG
Imazaquin + prodiamine + simazine	• Coastal 5L
Imazaquin + sulfentrazone	• Surepyc IQ 2.2L
Imazethapyr + sulfentrazone	• Dismiss South 4SC, Sulfen Southern 4L
Imazosulfuron	• Celero 75WDG

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Indaziflam	• Marengo 0.622L, Specticle Flo 0.622L, Specticle G, Rezilon 1.67L
Isoxaben	• Gallery 75DF & 4.16L, Isoxaben 75WG
Isoxaben + oxyfluorfen + trifluralin	• Showcase 2.5G
Isoxaben + prodiamine	• Gemini 3.7SC, Prodoxaben 3.7SC
Isoxaben + trifluralin	• Gallery + Team Woodace Preen Plus, Preen 1.9G, Preen Extended Control 1.875G, Snapshot 2.5TG,
Maleic hydrazide	• Retard, Royal Slo-Gro
MCPA	• MCPA-4 Amine, MCPA Ester 4, Weedar MCPA 4 lb/gal, Wildcard, + others
MCPP (mecoprop)	• Chickweed & Clover Control, Lescopex, MCPP-4 Amine, Mecomec 4, MCPP-4K + others
MSMA	• 120 Herbicide, 912 Herbicide, Bueno 6L, Crab-E-Rad, Daconate 6, Daconate Super, Dal-E-Rad, Drexar 530, MSMA 6.6L, MSMA Turf, Summer Crabicide, Target MSMA, Weed Hoe, + others
Mesotrione	• Lucto 4L, Meso 4L Select, Tenacity 4L, TRIONE
Methiozolin	• PoaCure 2SL
Methyl chlorflurenol	• Maintain CF
Metribuzin	• Metricor 75DF, Sencor 75DF
Metribuzin + sulfentrazone	• Rightline Sulfencore 0.45DG
Metolachlor	• Dual Magnum 7.62L, Me-Too-Lachlor 8L, Pennant 7.8 L, Pennant Magnum 7.62L
Metsulfuron	• Accurate 60 DF, Escort 60 DF, Manor 60 DF, Mansion, Metsulfuron Pro, MSM Turf, Patriot 60 WDG, Rometsol 60DF, + others
Metsulfuron + nicosulfuron	• Pastora 71DF
Metsulfuron + pyraflufen-ethyl	• Caliente
Metsulfuron + rimsulfuron	• Negate 37WG
Metsulfuron + sulfentrazone	• Blindside 66WG
Metsulfuron + sulfosulfuron	• Southside 75WDG
Methyl Bromide	• Brom-O-Gas, MB 98, MBC, Terr-O-Gas
Napropamide	• Devrinol 50 DF, 2G, 10G, Ornamental Herbicide 5G
Napropamide + oxadiazon	• PrePair 6G
Norflurazon	• Predict
Oryzalin	• Harrier 4L, Oryzalin Pro 4, Proazlin 4L, Surflan AS 4 lb/gal, Surflan Flex T&O, Weed Impede,
Oryzalin + oxyfluorfen	• Double O SPC, Rout 3G
Oxadiazon	• Oxadiazon 50 WSP, 2G, & SC, Ronstar 2G, 50WP, Ronstar Flo 3.17 L, Starfighter L
Oxadiazon + pendimethalin	• Jewel 3.25G, Kansel + (20-2-13) 3G
Oxadiazon + prodiamine	• Regalstar II 1.2G
Oxyfluorfen	• Goal 2XL
Oxyfluorfen + oxadiazon	• OO-Herbicide 3G, Regal OO,

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Oxyfluorfen + pendimethalin	• OH2
Paclobutrazol	• Armor Tech PAC 223, Cutdown, PAC 223, Trimmit 2SC, TGR, Tide Paclo 25C, Turf Enhancer 50WP/2SC
Paraquat	• Gramoxone Max 3L
Pelargonic Acid	• Axxe, Beloukha 4.21L, Scythe, Quik
Pendimethalin	• Corral 2.68G, Halts, Hammerkop, Hurdle, Pendiflex 32, Pendulum (3.3EC, 2G), Pendulum AquaCap (3.8 CS), Pentagon, Pin-Dee 3.3 T&O, PRE-M, ProPendi, Prowl, Turf Weedgrass Control,
Penoxsulam	• Grasp, Granite, LockUp G, Sapphire 0.31L
Penoxsulam + pyrimisulfan	• Aethon G
Pethoxamid	• StriCore 4L
Picloram	• Grazon, Tordon K
Pinoxaden	• Axial XL 0.42L, Manuscript 0.42L
Prodiamine	• Barricade 65WDG, Cavalcade, Endurance 65WDG, eVade 4L, Factor 65WDG, Guardrail 65WDG, Kade 65WDG, Knighthawk, ProClipse 65WDG, Prodiamine 4L & 65 WDG, RegalKade 0.5G & 0.37G, Resolute 4L/65WG, Stonewall, + others
Prodiamine + quinclorac	• Cavalcade PQ, Lesco Stonewall PQ
Prodiamine + sulfentrazone	• Echelon 0.3G/4SC
Prohexadione-Ca	• Anuew 27.5WP, Anuew EZ 0.98L
Pronamide	• Kerb 50WP, Kerb SC T&O 3.3L, Pronamide 3.3L
Pyraflufen-ethyl	• Octane 2%SC (0.177 lb/gal)
Pyrimisulfan	• Arkon 0.1L, Vexis 0.025%G
Pyroxasulfone	• Zidua 85WDG
Quinclorac	• Acclaim Accelerate 1.5L; Drive 75DF, Eject 4L/75DF, Facet, Paramount, Quinclorac 75DF/1.5L, QuinPro, Rook 4L, Quintessential 1.5L, XLR8 1.5L
Quinclorac + sulfentrazone	• Solitaire 75WG/WSL
Quizalofop-P-Ethyl	• Assure II 0.88L, Targa 0.88L
Rimsulfuron	• Matrix, Rimsulfuron 25DF, TranXit GTA 25DG, Titus
Sethoxydim	• Grass Getter, Poast, Poast Plus, Segment 1L, Segment II 1.5L, Sethoxydim G-Pro 1L, Vantage 1L
Siduron	• Tupersan 50WP/3.5G/4.6G, 470, Crabgrass Control
Simazine	• Princep 4L/T&O/80WP, Simazine 4L & 90DF, Wynstar, Sim-Trol 90DF, + others
Sulfentrazone	• Antares Pro 4L, Authority, Dismiss Turf Herbicide 4L, Spartan 4F, SULF 396, Sulfentrazone 4L, Surepyc 4L
Sulfometuron-methyl	• Oust 75DG, SFM G-Pro 75EG, Spyder 75DG,
Sulfosulfuron	• Certainty 75WDG, Credet 75WDG, Maverick, Monitor, Outrider 75WDG,
Tebuthiuron	• Spike 80DF, Tebuthiuron 20P
Topramezone	• Impact, Pylex 2.8SC,

Herbicide and PGR Common and Trade Names	
Common Name(s)	**Trade Name(s)**
Triclopyr	• Garlon 3A (amine), 4A (ester), & Ultra 4L (ester), Grandstand, Pathfinder 1L (RTU), Remedy Ultra, Tahoe 3A & 4E, Triclopyr 3A & 4E, Triclopyr 4, Triclopyr 4L Select, Trycera 2.87, Turflon Ester 4L, Vastalan 4L
Trifloxysulfuron	• Envoke 75WG, Monument 75WG, Recognition 20WDG (trifloxysulfuron + metcamifen herbicide safener)
Trifluralin	• Treflan 5G, Trifluralin 4EC, Trilin 4EC, 5EC, Preen, Vegetable and Ornamental Weeder
Trinexapac-ethyl	• Governor 0.055% 5-0-10; 0.17%, Groom PGR, Palisade, PGR 113, Podium 1L, Primo 1EC, Primo MAXX 1L, Primo WSP, RegiMax PGR, T-NEX, T-Pac Epro, Trin-Pac Select, Trinexapac-ethyl 1AQ, Triple Play,
Xanthomonas campentris	• X-Po

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 its 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 a porous, soft, black substance made by heating in a 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 lb of activated charcoal to every pound of active material spilled per acre (2.3 to 9.2 lb/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 lb/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 hr after treatment.

Example: Suppose Balan 2.5G was inadvertently applied at 2 lb ai/ac 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 1,000 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 lb 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.

Sources of Activated Charcoal (Carbon) – check the web for the latest information on these and other distributors.

Trade Name Examples	
D-Tox Flowable Charcoal	Impound Select – Prime Source
Brandt 52 Pickup Flowable Activated Charcoal	Harrell's Activated Charcoal
Norit Gro-Safe Activated Carbon	

Supplier Examples		
Harrell's PO Box 807 Lakeland, FL 33802 800-282-8007 www.Harrells.com	General Carbon Corp. 33 Paterson St. Paterson, NJ 07501 973-523-2223 www.sales@generalcarbon.com	Donau Carbon/Standard Purification 551 N. US Hwy 41 Dunnellon, FL 34432 888-616-5959 www.sales@standardpurification.com

VEGETATION MANAGEMENT & WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

Bert McCarty and Matt Cutulle

SITE/WEED	COMMON NAME (lb 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 bermudagrass is dormant for control of winter annual grass, tall fescue, and broadleaf weeds. 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 qt)	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. 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 label section for specific weed rate and recommended tank mixes for additional weed control). A methylated seed oil concentrate at 1.5 to 2 pt/acre enhances control of specific weeds. Early spring applications made prior to full green-up may delay bermudagrass green-up.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb 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 pt 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 lb) **or** DSMA (3.6 lb)	MSMA 6 L (2.7 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 pt 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.
	indaziflam (0.05 to 0.1) + rimsulfuron (0.03 to 0.06)	EsplAnade Sure (3 to 6 Ounces)	Controls summer and winter annual grasses as well as most small seeded/medium broadleaf weeds. Contains a postemergent herbicide active ingredient with residual (rimsulfuron) that regular esplanade does. Will control thistle species such as sowthistle and Russian thistle. Formulated as a water dispersible granule. Can be used in bareground scenarios as well
	nicosulfuron (56%) + metsulfuron (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 qt/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 & seedhead suppression, apply a second application at 4.0 fl oz/acre 6 to 8 weeks after the initial application. Amino Acid Derivative family.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb 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 pt/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 lb 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 (0.023 lb)	Oust 75DG (0.5 oz)	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 (2.7 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.
	foramsulfuron (0.023 lb to 0.09) + iodosulfuron (0.0023 to 0.009) + thiencarbazone-methyl (0.0094 to 0.0375)	Derigo (1.5 to 6 oz)	A postemergence herbicide that controls many annual and perennial broadleaf weeds and grasses in desirable warm-season grasses such as bermudagrass, centipedegrass and zoysiagrass, and in bareground sites. Derigo can also be used to suppress bahiagrass to reduce mowing requirements. Controls more than 130 broadleaf and grassy weeds. For bahiagrass growth regulation, apply at a rate of 1.5 to 3 ounces per acre. Apply spray mixtures within 5 days of mixing to avoid product degradation. Rainfall within 2 hours of spray drying may result in reduced weed control and may necessitate retreatment.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	indaziflam (0.07 lb)	Rezilon (5 oz)	Rezilon is designed to protect desirable grasses and control the unwanted grasses that grow in hayfields, non-irrigation ditchbanks, fire breaks and any sites managed for hay. It also helps support managing annual grasses in perennial grass.
	glyphosate (0.3 + 0.48 lb) + 2,4-D (0.45 + 0.72 lb)	Campaign 3.1L (1 to 1½ qt)	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 pt)	Add 1 to 2 qt 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 & 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.
	aminopyralid (0.11) +	Opensight 1.15L (3.3 oz)	Controls numerous broadleaf and woody weeds such as ragweed sicklepod, thistle species, and multiflora rose. Opensight and Streanline are non-volatile, but use care when applying in the vicinity of broadleaf crops especially tobacco, fruit trees, and ornamentals.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	metsulfuron (0.02)		
	triclopyr (1.5 lb)	Garlon 3A (2 qt) or Garlon 4 (1.5 qt) or Vastlan 4 (0.75 pt to 1.75 qt)	Apply to actively growing plants. Add 2 to 4 qt. nonionic surfactant per 100 gals of spray. May be tank mixed with 2,4-D or fluroxypyr to broaden spectrum of weed control. Synthetic Auxin family.
	2,4-D amine (1 to 4 lb)	2,4-D amine (1 to 4 qt)	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.
	aminopyralid (0.11) + florpyrauxifen (0.4)	TerraVue (2.85 oz)	For control of annual and perennial broadleaf weeds including invasive and noxious weeds, certain annual grasses, and certain woody plants and vines. The addition of a high quality non-ionic surfactant (of at least 80% active principal), methylated seed oil at 0.5 to 1.0 % volume per volume (2 to 4 quarts per 100 gallons of spray), or blended adjuvants (rate as directed on specific label) is recommended to enhance activity.
	glyphosate (0.3 to 0.6 lb) + 2,4-D amine (0.48 to 0.95 lb)	Campaign 3.1L (1 to 2 qt) 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 qt 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
	foramsulfuron (0.016 to 0.033) + iodosulfuron (0.002 to 0.004) + thiencarbazone (0.007 to 0.014)	Derigo 36.4WDG (3 to 6 oz)	For control of vaseygrass, dallisgrass, and johnsongrass plus a number of broadleaf weeds in bermudagrass, centipedegrass, and zoysiagrass. No for use on desirable cool-season grasses. For bahiagrass seedhead control, apply at 1.5 to 3 oz product per acre prior to summer heat/drought stress. A total of 6 oz/acre is allowed yearly. Use a NIS at 0.25 to 0.5% v/v and a minimum of 10 GPA. The additional of ammonium sulfate (1.5 to 3 lb/a) or urea ammonium nitrate (1.5 to 2 qt/a) may improve control of some difficult-to-control weeds in areas of high relative humidity for ammonium sulfate and areas of low relative humidity for urea ammonium nitrate.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Total Vegetation Control	Glyphosate (8 lb) + aminopyralid (0.11) + penoxsulam(0.05) + oxyflurofen (2.21)	RoundUp Pro (2 qt) + Milestone (7 oz) + Cleantraxx (4.5 pt)	Provides season long broadleaf weed and grass control. Apply underneath guardrails, cable rails, rock shoulders, etc.
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 gal water. Apply during periods of active growth from June to Sept. Will also kill locust, redbud, mimosa trees, clover, and sericea lespedeza. Synthetic Auxin family.
	triclopyr (see trade name rates)	Garlon 3A (1.5 to 2 gal)	Amine formulation. Used as a spot or broadcast treatment. Add 1 to 2 pt 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). Also look up Vastlan the choline salt formulation of triclopyr.
	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; 20 to 40 gal per acre for broadcast application. Thoroughly spray foliage and stems without excessive runoff. Sulfonylurea family.
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)	Roundup Pro 4L (4 to 8 fl oz/10-25 gal water)	Foliar absorbed. Apply to bahiagrass only. Add 2 qt 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.
	glyphosate + 2,4-D	Campaign 3.1L (16 to 24 oz/A)	
	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 & seedhead development plus control of certain broadleaf weeds. Make a second treatment 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 lb) or DSMA (3.6 lb)	MSMA 6 L (2.7 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 before grasses begin to send up new seedheads. Afternoon air temps. 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.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
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 prior to seedhead emergence (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)	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.
	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 & perennial broadleaf weeds. For effective thistle control, apply 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/ac can be applied per season 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 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, & 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 used on grass roadsides. Add a nonionic surfactant at 0.25% v/v to the spray mix.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Limb Trimming (side trimming)	fosamine (6 to 8 lb)	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 (0.62) **or** fluroxypyr (0.12)	Vaslan (2.5 qt) **or** Vista (10 oz)	Broad spectrum brush and vine control across a wide range of woody plant species. May be used as an under canopy treatment to mature trees without concern of root uptake. May be applied to terrestrial areas such as slopes, rock bluffs, etc. as well as wetlands and aquatic sites. Use on brush 6 feet or less in height to minimize brown-out.
	triclopyr (1 to 2 lb)	Garlon 4 (4 to 8 qt)	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 to 3% 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.
		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.
		Vastlan 4L (0.75 to 3.5 pt/a)	For woody plants, apply 0.5 to 9 qt/100 gallons of spray solution or for low volume foliage treatments, apply up to 3.75 gal in 10 to 100 gallons of finished spray. For best results, use a surfactant. See label for tank mixing with various other herbicides.
	fosamine (6 to 12 lb)	Krenite 4S (1.5 to 3 gal)	Used as a spot or broadcast treatment. Add nonionic surfactant at 1 qt/100 gals. Use 50 GPA as a broadcast application or 100 GPA 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.
	triclopyr (1.12) + aminopyralid	Capstone (9 pt)	Control of annual and perennial broadleaf weeds and woody plants and vines. Apply with 10 gallons per acre water carrier or higher GPA. Avoid nozzles that apply very fine droplets to prevent drift. A quarter percent non-ionic surfactant volume/volume added to the tank mixture will improve efficacy.
	glyphosate (2 to 8.1 lb)	Rodeo 5.4L (3 pt to 1.5 gal)	Used as a spot or broadcast treatment. Add 2 to 4 qt 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 qt) generic glyphosate 4L (3 to 7 pt)	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 qt nonionic surfactant per 100 gal solution for generic glyphosate. Amino Acid Derivative family.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	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 (1.5 to 3 qt)	Used as a spot treatment. Add 1 to 2 pt surfactant. Coverage should wet all leaves, stems, and root collars. Best control is in the spring immediately following flowering or in late summer (Aug to Nov).
		Garlon 4 (1.5 gal/100 gal solution)	Used as a spot treatment in 20 to 30 gal water per acre. Add 1 to 2 pt surfactant. Treat dormant brush with most of the foliage dropped (Jan through March). Synthetic Auxin family.
	glyphosate (3 to 4 lb)	Roundup Pro 4L (3 to 4 qt)	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 qt nonionic surfactant per 100 gal spray for generic glyphosate. Amino Acid Derivative family.
	glyphosate (1 to 1.5% solution)	Roundup Pro 4L (1 to 1.5 gal/100 gal)	
	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.
	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 qt)	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 any time after cutting, including winter months. Used as an individual cut stump treatment. Add 25 gal Basal Oil per 100 gal spray. Used as a spot treatment in a squirt bottle, paintbrush, 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 an oil soluble dye. May also be used during the dormant season (December through March) instead of Roundup Pro.
		Vastaln 4L	Spray or paint freshy cut stumps with undiluted product. See label for other specialty injection and girdling applications.
	aminopyralid	Milestone (2% solution)	For cut stump: Use to treat any deciduous tree which is handcut to prevent resprout. Treat cambium area, any remaining bark down to the ground line, and exposed roots. Apply similar to spray paint. Best when combined with 20% Garlon and 78% basal oil indicator + dye.
	triclopyr (1 lb)	Pathfinder II 1L (100% solution, ready to use)	Apply any time 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.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	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 an 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 (up to 1 year, less control will be observed if significantly greater rainfall is observed)	imazapyr (1.0 lb) + diuron (2.4 to 4)	Arsenal 2S (2 qt) + 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.
	imazapyr (0.48 to 1 lb) + diuron (3.73 to 8.09 lb)	Sahara DG (6 to 13 lb)	Tank mix with Roundup Pro for quicker control of emerged vegetation. Do not apply near roots of desirable plants.
	indaziflam (.05 to 0.1) + aminocyclopyrachlor (0.125 to 2.5) + imazapyr (0.38 to 0.76)	Plainview (32 to 64 oz)	A comprehensive product that provides extensive burndown and preemergent control of many broadleaf weeds, grasses, sedges and rush species. To maximize POST activity and non-ionic surfactant should be applied at
	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.
	indaziflam (0.09)	EsplAnade (3.5 to 7 oz)	Provides PRE control of grasses and small to medium sized broadleaf weed species. Can couple with Method 240 SL for burndown in both bareground scenarios and bermudagrass
	diquat + glyphosate + indaziflam (10.5 lb ai/A)	Specticle Total 1.95L (5.4 gal/A)	Mix 16 fl oz/gal of water to cover 1,000 ft^2. Maximum yearly use rate of 32 fl oz/1,000 ft^2. Make a subsequent application 4 months after the initial to extend weed control. For non-selective weed control in ornamental beds, apply only to established plants ($\geq$1 yr old) and prior to mulching.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
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 lb)	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 1 qt fl oz/A for additional knock down of larger vegetation. For best results, use a MSO at 1.5 to 2 pt/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 lb 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 pt/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 (0.25 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.
	glyphosate (0.5 to 3 lb) See Remarks	Roundup Pro 4L (0.5 to 3 qt) See Remarks	Used as a broadcast treatment at 1 pt/acre for burndown of smaller plants up to 12 inches tall & 2 to 3 qt/acre for larger plants in the boot to head stage. Best with summer (June to Aug) treatments. Generic glyphosate 4L may also be used as a 0.75% solution (3 qt/100 gal spray) spot treatment. Use 3 to 4.5 pt/acre for broadcast treatment. Add 2 to 4 qt nonionic surfactant per 100 gal spray. Treat only actively growing plants (June through September). Will cause temporary discoloration & 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.

VEGETATION MANAGEMENT AND WEED CONTROL ALONG ROADSIDES, INDUSTRIAL SITES, FIELDS, COMMON AREAS[1]

SITE/WEED	COMMON NAME (lb ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	MSMA (2 lb) **or** DSMA (3.6 lb)	MSMA 6 L (2.7 gal) **or** DSMA 3.6 L (1 gal)	Applied April through August every 4 to 6 weeks for suppression/control of emerged weeds. Two to 3 applications may be needed for control. Apply in 40 GPA. 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 pt/acre. Add 0.5% nonionic surfactant (2 qt/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 lb)	Surflan 2AS (3 to 6 qt)	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 lb)	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 apps 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 qt)	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 lb per 100 gal of carrier. Apply in 20 to 40 gal water per acre. A surfactant is not needed. Treat small weeds (<6-in tall) for best results. Use care when applying in the vicinity of 2,4-D sensitive crops such as vegetables, cotton, tobacco, fruit trees, and ornamentals. Use appropriate drift control agent. Control is slow (2 to 4 weeks).
	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 MSO concentrate at 1.5 to 2 pt/ac enhances 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. To avoid turf damage, only dormant bahiagrass should be treated. Apply on bahiagrass in late Dec to early Feb. and use lower rate of 16 oz/a, as delayed greenup can be expected.

Note: Numerous weed species are become resistant to various herbicides. Follow these weed control practices to prevent resistant weeds. (1) Tank mix herbicides with other herbicides that have a different mode-of action (e.g. Roundup, 2,4-D, etc.). (2) Do not let weed escapes go to seed. (3) Respray (or rotate) problem areas with a herbicide with a different mode-of-action than the initial herbicide used.

[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.

Additional References for Vegetative Management

Corteva Product Listing: https://www.corteva.us/products-and-solutions/land-management.html

Bayer Product Listing: https://www.backedbybayer.com/vegetation-management/products#?filters=IVM

BASF Product Listing: http://www.bettervm.basf.us/products/products-landing-page.html

Naturechem Programs: https://www.naturchemstore.net/services/roadside-vegetation/

DBI Programs: http://www.dbiservices.com/vegetation-management

Weed ID Guide: https://www.clemson.edu/cafls/research/weeds/weed-id-bio/index.html

Company Specific Selective Weed Control Strategies for Roadsides

Envu Fall Based Weed Control Program Calander Year for Selective Weed Control on Roadsides

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
survey site for weed species present			Method + Derigo			Survey site for Weed Species	Mow	Esplanade + Method			

Corteva Analysis for Invasive Species Control along Roadsides

Estimated Cost			
Hand Removal	**Mowing**	**Targeted Herbicide Application**	**Broadcast Herbicide Application**
$122 per acre	$70 to 150 Per mile strip	$13 to 87 per acre	$12 to 65 per acre

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; Spray-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 leaf adherence	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; Umbrella; Jetwet; Chem-Stik; Di-aqua
Surfactant/ Spreader/Wetting Agent	Surface-active agents improve the emulsifying; dispersing, spreading, or wetting 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; Aquabond; 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; Inside-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 (triclopyr)	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 (clopyralid)	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

Matt Cutulle

Aquatic weeds in ponds or lakes used as sources for irrigation water can be controlled by physical removal, benthic barriers, biological control, or herbicides. Method (s) 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. 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.

For site specific control of nuisance weeds a benthic barrier can be used. Benthic barriers may be effective for control of aquatic plants that are not free flowing. A geotextile barrier attached to a frame (typically wooden) can be placed at the bottom of the problem area of the pond. Necrotic vegetation underneath the barrier will results in excessive air bubbling, thus the barrier should be partially lifted periodically to release pressure. The material to construct a benthic barrier can be found at (https://www.usfabricsinc.com/products/us-160nw).

Limiting sediment run off or accumulation of sediment can be a preventative measure to reduce aquatic weeds. Over time sediment run off can make the pond shallower which increases light penetration and water temperature, which is condusive to weed growth. Dredging the pond-lake periodically will reduce sediment accumulation. A pond should be dredged if there is abundant debris in the pond emits a foul smell, has noticeably shrunk, fish numbers have significantly decreased, reduced oxygen levels, excessive algae growth or no variance in temperature at different depths. To dredge create a channel in the pond, use an appropriately sized dredge boat (INFOGRAPHIC | When and How To Dredge A Pond | Geroform (geoforminternational.com) to remove built up sediment layers and refill pond through constructed channel.

When constructing a pond, the depth of the pond should be at least 3 feet to reduce weed infestations from occurring. Edges should be constructed gradually enough to prevent bank sloughing. If anticipated water level is more than 1 foot below existing ground level, then further bank grading is beneficial. The ideal depth of a pond is 6-8 feet. Most biological production occurs near the water surface and water deeper than 8 feet is of little value as fish habitat if fish are desired. Very deep water (>10') may even create conditions that lead to oxygen depletions and fish kills during the summer. About 25% of the pond's area should be allotted to shallow' habitat, between three and four feet deep

Use of nutrient binding materials such as lanthanum, alum, calcium carbonate reduce nutrient accumulation and algae growth. Phosphlock and Phosphate Binder are commercial products that can reduce nutrient availability in ponds. Aeration also reduces nutrient availability by driving chemical interactions which allow metals to bond with phosphate, formation of insoluble phosphorous compounds and removal of available Phosphorus. Another technique called circulation prevents stratification and results in cooler water temperatures that are less conducive to production of noxious algae/bacteria

UV-C light directing machines are an emerging technology that may help with aquatic weed control in the future. Currently this technology is being used in Lake Tahoe California. The new UV light array tool is mounted underneath a small barge. The barge patrols the lake and the light array has been shown to be effective at killing underwater vegetation of at least 10 feet in height. In the three years that this technology has been implemented a significant improvement in weed control around Marinas has been observed. The technology was developed by Inventive Resources, Inc. A recent update on the technology can be found at https://www.unr.edu/nevada-today/news/2020/tahoe-aquatic-invasive-species.

UAV or drone technologies are emerging on the aquatic weed control market. The company SOLitudue has developed drone technologies to deal with giant cattail species, Salvinia , water hyacinth and many more aquatic and shoreline weeds. The drones from SOLitude have been constructed by leading edge aerial technologies for commercial lake and shore application with wing spans greater than 6 ft. and a robot RTK GPS navigation system. This allows for separate mapping and spraying applications to conserve herbicide and avoid damage to non-target species. The link to the South Carolina office is listed here Expert Wetland, Lake, Pond, & Fisheries Management In South Carolina

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. 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.
Bispyribac-Sodium	1 to 2 oz per acre, 20-40 ppb for subsurface applications
Carfentrazone	3.4 to 13.5 fl. oz. per surface acre for floating vegetation – 0.143 to 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	10 to 90 ppb. Follow label and check with company rep for exact recommended 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.

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/

http://el.erdc.usace.army.mil/aqua/apis/apishelp.htm

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

http://www.weedscience.ncsu.edu/aquaticweeds/

https://hgic.clemson.edu/factsheet/aquatic-weed-control-overview/

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	Penoxsulam
				Aquathol K & G	Hydrothol G & 191									
ALGAE														

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	Penoxsulam
				Aquathol K & G	Hydrothol G & 191									
Filamentous	E	P	P	–	G	G	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	P	G	P	P	E	E	P	P	–	G	–	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	G	E	E	G	E	P	P	–	–	–	–	–
Egeria	G	P	G	P	P	–	E	P	P	–	–	–	–	E
Elodea	G	–	E	P	P	–	E	P	P	–	–	–	–	E
Eurasian watermilfoil	P	E	G	E	E	G	E	P	P	E	–	F	G	E
Fanwort	P	F	G	E	E	G	E	P	P	–	–	–	–	–
Hydrilla	G	P	G	G	G	G	E	P	P	–	–	G	–	E
Naiads	P	F	E	G	G	G	E	P	P	–	–	–	–	G
Parrotfeather	P	E	E	G	G	–	–	F	P	G	E	G	G	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	G	–	–
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
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	–	–	–	E	P	P	–	–	F	–	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	Penoxsulam
				Aquathol K & G	Hydrothol G & 191									
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	–	–	–	E	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.

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

Common Name	Trade Name	Irrigation	Fish Consumption	Watering Livestock	Swimming
Bispyribac-Sodium	Tradewinds	See Note 8	NR	NR	NR
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 **<u>may</u>** allow irrigation on established turf, immediately. CHECK INDIVIDUAL LABEL. Freelexx Herbicide by Corteva contains the choline salt of 2,4 D, which has very low volatility.			
Diquat	Reward	1 to 3[4]	NR	1	NR
	Weedtrine D	5	NR	5	NR
	Harvester	5	NR	1	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 to 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, Vastlan (Contains choline salt of triclopyr, lower volatility)	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.
[8] Treated irrigation water can be applied to St. Augustinegrass and bermudagrass with the exception of golf course greens.

TANK-MIXING CHEMICALS

Dara Park, PhD and Juang-Horng 'J.C.' Chong, PhD

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:

I. 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.
II. Read the label of all chemical 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.
III. Perform a jar test following proper mixing procedures (Table 1). This will determine physical incompatibilities.
IV. 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.
V. 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.
VI. 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 OTHER MISCELLANEOUS USEFUL INFORMATION

Bert McCarty

Acres covered/hour:	= MPH x Swath (ft) x 0.1212	or	MPH x Swath (ft) / 8.25
Gallons Per Acre (GPA):	= GPM (whole boom) x 495 / MPH x Swath (ft)	or	GPM per nozzle x 495 / MPH x nozzle spacing (ft)
	= GPM per nozzle x 5940 / MPH x nozzle spacing (inches)	or	GPM per nozzle x 5940 / MPH x width of nozzle spray (inches)
	= fl.oz collected per nozzle in 100 ft x 40.8375 / nozzle spacing (inches)	or	fl.oz. collected per nozzle x 4084 / ft. traveled x nozzle spacing (inches)
	= gallons collected per nozzle x no. nozzles x 43560 / ft. traveled x Swath (ft)	or	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):	= GPA x MPH x Swath (ft) / 495	or	fl.oz per minute / 128
	= GPA x MPH x nozzle spacing (inches) x no. nozzles / 5940		
GPM/Nozzle:	= GPA x MPH x nozzle spacing (inches) / 5940	or	GPA x MPH x nozzle spacing (ft) / 495
	= Test jar fl.oz x 0.46875 / seconds to fill test jar	or	7.5 / seconds to fill 1 pint (16 fl.oz.)
	= 15 / seconds to fill 1 quart (32 fl.oz.)		
Minutes/Acre:	= 495 / MPH x Swath (ft)	**Acres covered per tank**:	= Gallons per tank / GPA
Minutes/load:	= gallons/load x 495 / MPH x GPA x Swath (ft)	**Material needed per tank**	= rate/A x gallons/tank / GPA
Travel Speed (Miles Per Hour, MPH)	= Distance traveled (ft) x 0.68 / 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:

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

Fluid Application

lb/acre nutrient applied	= 0.226464 x element concentration (ppm) x acre inches of solution applied		
PPM	= 1,000,000 x lb ai used / gal/tank x 8.34	or	wt. of material to be used (lb) x 1,000,000 / wt. of tank mixture (lb)
	= 1,000,000 x oz commercial material used x % ai (decimal) / gal/tank x 8.34 x 16	or	1,000,000 x fl.oz. used x lb ai/gal / gal/tank x 8.34 x 128
lb ai to use per tank	= PPM desired x gal/tank x 8.34 / 1,000,000	or	ppm desired x gal/tank x 8.34 / 1,000,000 x % ai
lb commercial material to use per tank	= PPM desired x gal/tank x 8.34 / 1,000,000 x % ai (decimal)	or	% desired x gal/tank x 8.34 / % ai (decimal)
fl. oz. to use per tank	= PPM desired x gal/tank x 8.34 x 128 / 1,000,000 x ai per gal		
gal commercial material to use per tank	= ai (decimal) x 8.34 x gal/tank / ai per gal x 100		
% ai in a spray mix	= lb. commercial material used x % ai (decimal) / gal/tank x 8.34		
gal commercial material for total treated acres	= PPM desired x GPA x acres x 8.34 / 1,000,000 x lb ai/gal		

Active Ingredients (ai)

lb commercial material/acre	= lb ai to be applied per acre / % ai of material	**gal commercial material/tank**	= gallons/tank x lb ai to be applied per acre / gallons/acre x lb ai per gallon
gal commercial material/acre	= lb ai to be applied per acre / lb 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

Approximate Rates of Application Equivalents

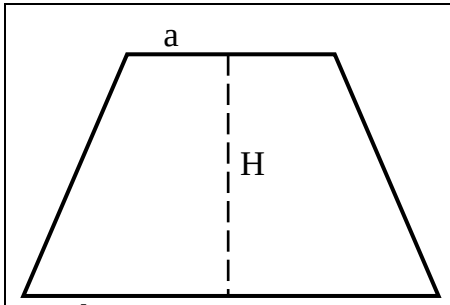
Weights			**Liquid**		
1 oz/ft^2	= 2722.5 lb/A		1 oz/1000 ft^2	= 43.56 oz/A	= 1.4 qt/A
1 oz/yd^2	= 302.5 lb/A		1 pt/1000 ft^2	= 5.4 gal/A	
1 oz/100 ft^2	= 27.2 lb/A		100 gal/A	= 2.3 gal/1000 ft^2	= 1 qt/100 ft^2
1 oz/1000 ft^2	= 43.46 oz/A	= 2.72 lb/A			
1 lb/A	= 1 oz/2733 ft^2	= 8.5 g/1000 ft^2			
100 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			

Calculations and Formulas for Various Shapes:

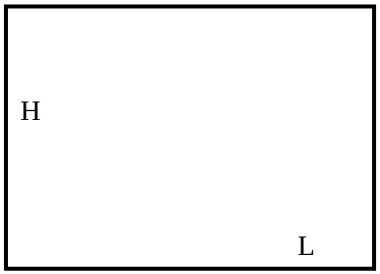
Rectangle, square or parallelogram:	area	=	length (L) x width (W)		
Trapezoid:	area	=	[a + (b x h)] ÷ 2		
Circle:	area	=	radius (r)^2 x 3.1416 (or π)	=	diameter (d)^2 x 0.7854
	radius	=	d ÷ 2		
	diameter	=	r x 2		
	circumference	=	π x d		
Sphere:	volume	=	r^3 x 4.1888	=	d^3 x 0.5236
Triangle:	area	=	½(b x h)		
Cylinder:	volume	=	r^{2}πL		
Cone:	area	=	⅓(πr^{2}h)		
Cube:	volume	=	length x L x L		

Finding Tank Capacity (gallons):

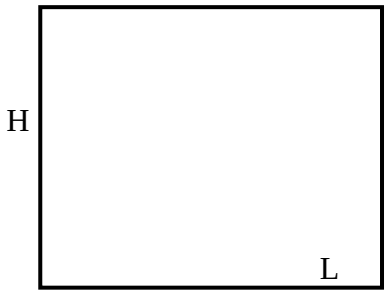
Cylindrical tanks:	**(inches)**	=	L x d^2 x 0.0034
	(feet)	=	L x d^2 x 5.875
Rectangle tanks:	**(inches)**	=	L x W x height x 0.004329
	(feet)	=	L x W x height x 7.48
Elliptical tanks:	**(inches)**	=	L x short diameter (sd) x long diameter (ld) x 0.0034
	(feet)	=	L x sd x ld x 5.875



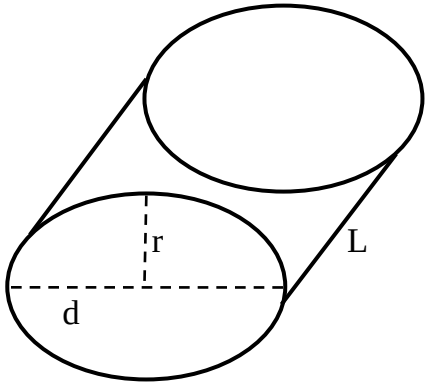
Trapezoid



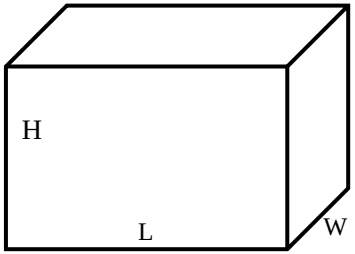
Rectangle



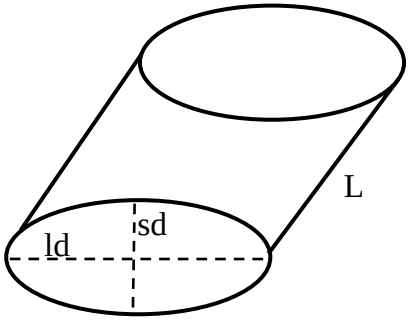
Square



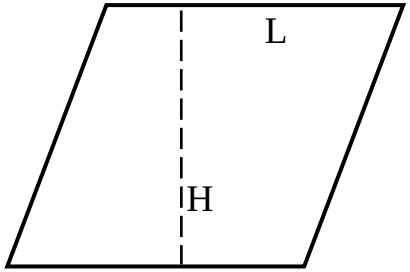
Cylindrical Tank



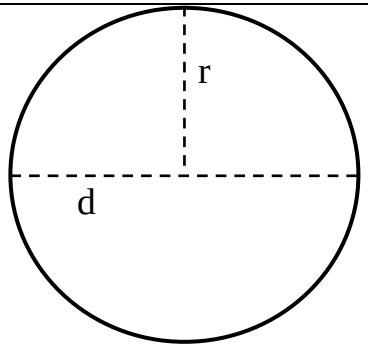
Rectangular Tank



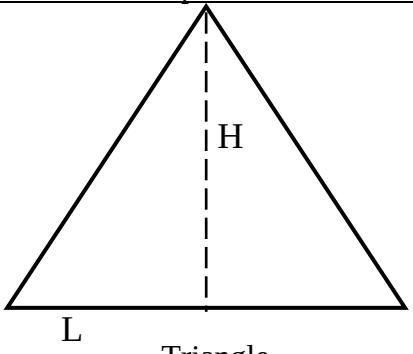
Elliptical Tank



Parallelogram



Circle



Triangle

Peat Moss Coverage

Depth (inches)	Coverage (sq.ft.)	
	5.6 ft^3 Bale (compressed) covers	**4.0 ft^3 Bale (compressed) 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 in^3	=	3,630 ft^3	
1 inch 1,000 ft^{-1}	=	620 gal	=	83 ft^3			
1 gallon	=	0.134 ft^3	=	8.34 lb	=	231 in^3	
1 million gallon	=	3.07 acre-feet					
7½ gallons	=	1 ft^3					
1 acre-foot	=	325,851 gal	=	43,560 ft^3			
1 pound of water	=	0.1199 gal					
Precipitation rate (in/hr)	=	$\frac{\text{gpm x 96.3}}{\text{area } (ft^2)}$					

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

Approximate Weight of Dry Soil

Type	Bulk Density	Weight		
	g cm^{-3}	lb ft^{-3}	kg m^{-2}	lb $acre^{-1}$ (6-in deep)
sand	1.6	100 (or 2700 lb yd^{-3})	1,623	2,143,000
loam	1.3 to 1.55	80-95	1,299-1,542	1,714,000
clay or silt	1.0 to 1.30	65-80	1,055-1,299	1,286,000
muck	0.65	40	649	860,000
peat (compact)	0.325	20	325	430,000

Sand weights (tons): = yd^3 x 1.3
Gravel weights (tons): = ft^3 x 110

-0.5- to 1-in diameter gravel = 2,700 lb/yd^3

-0.25- to 0.375-in diameter gravel = 3,000 lb/yd^3

Approximate Organic Materials for 6-inch depth per 1,000 ft^2 (weight variance in materials may occur)

Organic Material Volume in Mix	Approximate thickness applied to soil surfaces		Organic Material Needed	
%	in	cm	yd^3 1,000 ft^{-2}	m^3 100 m^{-2}
5	0.33	0.84	1.0	0.83
10	0.67	1.70	2.0	1.70
15	1.00	2.54	3.0	2.48
20	1.33	3.38	4.0	3.30
25	1.67	4.24	5.0	4.16
30	2.00	5.08	6.0	4.95

Example: If 10% organic materials is incorporated into the top 6-inches of a 1,000 ft^2 area, the organic material is applied to a depth of 0.67-in and 2.0 yd^3 will be needed (1.7 cm and 1.7 m^3 100 m^2).

Surface Area Impacted and Topdressing Sand Needed to Fill Aerification Holes.

Spacing	Tine Diameter	Tine Diameter	Holes ft^{-2}	Surface Area Impacted	Dry Sand to Fill Holes 3-in Depth	
in	in	mm	no.	%	~ft^3 1,000 ft^{-2}	~lb 1,000 ft^{-2}
1.0 x 1.0	0.250	6.350	144	4.91	12.3	1227
	0.375	9.525	144	11.04	27.6	2761
	0.500	12.700	144	19.63	49.1	4909
	0.625	15.875	144	30.68	76.7	7670
	0.750	19.050	144	44.16	110.4	11040
	1.000	25.400	144	78.50	196.4	19640
1.0 x 2.0	0.250	6.350	72	2.45	6.1	614
	0.375	9.525	72	5.52	13.8	1381
	0.500	12.700	72	9.82	24.5	2454
	0.625	15.875	72	15.34	38.4	3855
	0.750	19.050	72	22.09	55.2	5520
	1.000	25.400	72	39.27	98.2	9820
1.5 x 1.5	0.250	6.350	64	2.18	5.5	550
	0.375	9.525	64	4.91	12.3	1230
	0.500	12.700	64	8.72	21.8	2180
	0.625	15.875	64	13.63	34.1	3410
	0.750	19.050	64	19.63	49.1	4910
	1.000	25.400	64	34.89	87.3	8730
2.0 x 2.0	0.250	6.350	36	1.23	3.1	307
	0.375	9.525	36	2.76	6.9	690
	0.500	12.700	36	4.91	12.3	1227
	0.625	15.875	36	7.67	19.2	1917
	0.750	19.050	36	11.04	27.6	2760
	1.000	25.400	36	19.63	49.1	4910
7.0 x 7.0	0.750	19.050	2.94	0.90	2.3	230
(drill & fill)	1.000	25.400	2.94	1.60	4.0	400

METRIC SYSTEM CONVERSION

Bert McCarty

Metric Prefix Definitions (basic metric unit = 1)

tera	=	10^{12}	deci	=	10^{-1}
giga	=	10^{9}	centi	=	10^{-2}
mega	=	10^{6}	milli	=	10^{-3}
kilo	=	10^{3}	micro	=	10^{-6}
hecto	=	10^{2}	nano	=	10^{-9}
deca	=	10^{1}	pico	=	10^{-12}

Metric Prefix Example (weight)

1 kg	=	10^{3} g	=	10^{6} mg	=	10^{9} μg	=	10^{12} ng
1 g	=	10^{-3} kg	=	10^{3} mg	=	10^{6} μg	=	10^{9} ng
1 mg	=	10^{-6} kg	=	10^{-3} g	=	10^{3} μg	=	10^{6} ng
1 μg	=	10^{-9} kg	=	10^{-6} g	=	10^{-3} mg	=	10^{3} ng
1 ng	=	10^{12} kg	=	10^{-9} g	=	10^{-6} mg	=	10^{-3} μg

Metric Prefix Example (volume)

1 L	=	10^{3} mL	=	10^{6} μL
1 mL	=	10^{-3} L	=	10^{-6} μL
1 μL	=	10^{-6} L	=	10^{-3} mL

Area Equivalents

1 acre	=	43,560 ft^2	=	4840 yd^2	=	0.4047 hectares (ha)	=	160 $rods^2$	=	4047 m^2	=	0.0016 mi^2
1 ha	=	10,000 m^2	=	100 are	=	2.471 acres	=	107,639 ft^2				
1 yd^2	=	9 ft^2	=	0.836 m^2				1 yd^3	=	27 ft^3	=	0.765 m^3
1 ft^2	=	144 in^2	=	929.03 cm^2	=	0.09290 m^2		1 m^2	=	10,000 cm^2		
1 ft^3	=	1728 in^3	=	0.037 yd^3	=	0.02832 m^3	=	28,320 cm^3				
1 acre-inch	=	102.8 m^3	=	27,154 gal	=	3630 ft^3						

Liquid Equivalents

1 gal	=	4 qt	=	8 pt	=	16 cups	=	128 fl oz	=	8.337 lb				1 barrel	=	42 gal
	=	231 in^3	=	256 tbsp	=	0.134 ft^3	=	3.785 L	=	3785 ml						
1 qt	=	0.9463 L	=	2 pt	=	4 cups	=	32 fl oz	=	64 tbsp	=	57.75 in^3	=	946.4 ml		
1 L	=	2.113 pt	=	1000 ml	=	1.057 qt	=	33.8 fl oz	=	0.26 gal	=	0.0001m^2	=	1,000 cm^3		
1 pt	=	16 fl oz	=	2 cups	=	473.2 ml	=	32 tbsp	=	0.125 gal	=	0.5 qt				

1 cup	=	8 fl oz	=	0.5 pt	=	16 tbsp	=	236.6 ml	1 tbsp	=	14.8 ml	=	3 tsp	=	0.5 fl oz
1 fl oz	=	29.57 ml	=	2 tbsp	=	6 tsp	=	0.0313 qt	1 tsp	=	4.93 ml	=	0.1667 fl oz	=	80 drops
1 ft^3 of water			=	7.5 gal	=	62.4 lb	=	28.3 L	1 ml	=	1 cm^3	=	0.034 floz	=	0.002 pt

Pressure Equivalents

1 mmHg	=	133.32 Pa	=	0.133 kPa	=	133,333 mPa									
1Pa	=	10^{-3} kPa	=	10^{-6} mPa											
1 PSI	=	6.9 kPa	=	2.31 ft head											
1mPa	=	10^{3} kPa	=	10^{6} Pa	=	10 bar	=	10.2 kg cm^{-2}	=	100 N cm^{-2}					
1 atm	=	760 mmHg	=	29.92 in Hg	=	1.013 x 10^{5} Pa	=	1.013 bar	=	14.69 psi	=	33.89 ft water			
1kPa	=	0.001mPa	=	10 cm H_2O	=	10 mbar	=	0.01 bar	=	1J kg^{-1}	=	0.0099 atm	=	0.145 psi	

Temperature Equivalents

ºC	=	(°F-32)	x	5/9
ºF	=	(°Cx9/5)	+	32

Length Equivalents

km	=	0.621 statute mile	=	1,000 m	=	100,000 cm	=	3,281 ft	=	39,370 in			
m	=	3.28 ft	=	39.4 in	=	100 cm	=	1.094 yd	=	1,000 mm			
cm	=	0.3937 in	=	0.01 m	=	0.03281 ft							
in	=	2.54 cm	=	25.4 mm	=	0.0254 m	=	0.08333 ft					
ft	=	0.3048 m	=	30.48 cm	=	12 in							
yd	=	0.9144 m	=	3 ft	=	91.44 cm							
statute mile	=	1,760 yd	=	5,280 ft	=	1.61 km	=	1609 m					

Mixture Ratios

1 mg g^{-1}	=	1000 ppm	=	1 fl oz gal^{-1}
1 fl oz/100 gal	=	75 ppm	=	1 qt/100 gal
1 pt/100 gal	=	1 tsp/gal		

Flow

7490 ppm	=	1 gpm	=	0.134 ft^3 min^{-1}	=	0.06308 L sec^{-1}	
2 tbsp gal^{-1}	=	1 ft^3 min^{-1}	=	448.83 gal hr^{-1}	=	7.481 gal min^{-1}	
1 $ft^3 sec^{-1}$	=	448.83 gal min^{-1}					

Weight Equivalents

1 ton (US)	=	2,000 lb	=	0.907 metric tons	=	907.2 kg	1 metric ton	=	10^{6} g	=	1,000 kg	=	2,205 lb		
1 lb	=	16 oz	=	453.6 g	=	0.4536 kg			1 oz (wt)	=	28.35 g	=	0.0625 lb		
1 g	=	1,000 mg	=	0.0353 oz	=	0.001 kg	=	0.002205 lb	1 mg	=	0.001 g				
1 kg	=	1,000 g	=	35.3 oz	=	2.205 lb			1 µg	=	10^{-6} g	=	0.001 mg		
ng	=	10^{-9} g	=	0.001 micrograms (µg)					picogram	=	10^{-12} g				
1% (v/v)	=	1.28 fl oz/gal	=	1 gal/100 gal	=	10,000 ppm	=	10 g/L	=	1g/100 ml	=	1.33 oz (wt)/gal	=	8.34 lb/100 gal	

1 ppm	=	0.0001%	=	1 mg/kg	=	1 mg/L	=	1 µg/g	=	1µl/L	=	1µg/ml							
	=	0.379 g/100 gal	=	8.34×10^{-6} lb/gal	=	0.013 fl oz/100 gal				10 ppm	=	0.001%	=	10 mg/L					
	=	1 g m^{-3}	=	1,000 ppb	=	1000 µg/kg													
100 ppm	=	0.01%	=	100 mg/L				1,000 ppm	=	1 mg/g	=	0.1%	=	1,000 mg/L					
1 ppb	=	1 µg/kg	=	1 µg/L	=	1 ng/ml	=	1 ng/1,000,000,000				1 ppt	=	1 picogram/g					

Water and Soil Calculations

1 mmhos cm^{-1}	=	1,000 µmhos cm^{-1}	=	1 dS m^{-1}	=	0.1 S m^{-1}	=	1mS cm^{-1}	= 10 meq L^{-1}
1 meq L^{-1}	=	1 mmol L^{-1}	=	1mol m^{-3}					
1 meq 100g^{-1}	=	1mmol 100g^{-1}	=	cmol kg^{-1}					
Electrical conductivity (mmhos cm^{-1} or dS m^{-1})				x 640	=	Total dissolved salts (mg L^{-1} or ppm)			
Total dissolved salts (mg L^{-1} or ppm)				x 0.0016	=	Electrical conductivity (mmhos cm^{-1} or ds m^{-1})			

Energy

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

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
⅛	**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

Metric Conversion

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	cu. meter (m^3)

Metric Conversion

To Convert	Multiply by	To Obtain
Acre-inch	102.8	m^3
Bar	14.5	lb/in^2
Bar	1019.7	g/cm^3
Bar	29.53	inches Hg @ 0ºC
Bar	75	cm Hg @ 0ºC
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 = cm sec^{-1} = cm per sec	1.9685	ft/min
cm/sec	0.0223694	miles per hour (MPH)
cm^2 (square centimeters)	0.001076	ft^2
cm^2	0.1550	in^2
cm^2	0.01	sq. decimeter
cm^3 (cubic centimeters)	0.0610237	in^3
cm^3	0.0000353	ft^3
cm^3	0.0338	fl oz
cm^3	0.001057	qt^3
cm^3	0.000264172	gal
cm^3	0.001	cu. decimeter
Cup	8	fl oz
Cup	236.6	cm^3
Feet (ft)	30.48	cm
ft	0.3048	m
ft	305	mm

Metric Conversion

To Convert	Multiply by	To Obtain
ft^2 (square feet)	929	cm^2
ft^2	0.0929	m^2
ft^2	9.294×10^{-6}	hectares (ha)
ft^2	144	in^2
ft^3 (cubic feet)	28,329	cm^3
ft^3	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	ml
Gal	128	ounces (liquid)
Gal	0.13368	ft^3
Gal	231	in^3
Gal	3,785	cm^3
Gal	0.003785	m^3
Gal per acre (gpa)	9.354	L/ha
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}	ft^3/second
Gal/min	0.06309	L/sec
Gal/min	0.227125	m^3/hr
Grams (g)	0.002205	lb
Gram	0.035274	oz
g/cm^3	0.036127	lb/in^3

Metric Conversion

To Convert	Multiply by	To Obtain
g/cm^3	62.428	lb/ft^3
g/ft^2	96	lb/acre
g/ha	0.000893	lb/acre
g/ha	0.014275	oz/acre
g/kg	0.10	percent (%)
g/liter	1000	PPM
g/liter	10	%
g/liter	0.00834595	lb/gal
g/liter	0.13351	oz/gal
g/m^2	0.00020481	lb/ft^2
g/m^2	0.20481	lb/1,000 ft^2
Hectares (ha)	2.471	Acres
Ha	107,639	ft^2
Ha	107.64	1,000 ft^2
horsepower (electrical or mechanical)	746	watts
hp	550	ft-lb/sec
hp	33,000	ft-lb/min
hp	1.014	metric horsepower
hp	33,000	ft lb/min
Inches (in)	2.540	cm
Inches	0.0254	m
Inches	25.40	mm
Inches of mercury	3.4	kilopascals (kPa)
in/acre	6.28	cm/ha
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
in^3/hr	0.00434	gal/hr
Joules per kilograms (J/kg)	1	kPa

Metric Conversion

To Convert	Multiply by	To Obtain
Kilograms (kg)	2.2046	lb
kg/hectare	0.892	lb/acre
kg/ha	0.02048	lb/1,000 ft^2
kg/100 m^2	2.048	lb/1,000 ft^2
kg/L	8.3454	lb/gal
Kilometers (Km)	100,000	cm
Kilometers	3281	ft
Kilometers	1000	m
Kilometers	0.6214	miles
Kilometers	1094	yd
Km/h	0.62137	mph
Km/h	54.6807	ft/min
Kilopascals (kPa)	0.145	lb/in^2 (psi)
kPa	1	0.01 bar
kPa	1	J/kg
kPa	0.01	bar
Liters (L)	0.2642	gallons
L	33.814	fl.oz.
L	2.113	pt
L	1.057	qt
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	gal/A
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	ft
Meters	39.37	in

Metric Conversion

To Convert	Multiply by	To Obtain
Meters	1.094	yd
Meters	100	cm
Meters	0.001	km
Meters	1000	mm
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
M^3 (cubic meters)	35.3147	ft^3
M^3	1.30795	yd^3
M^3	264.20	gal
M^3	1,000	L
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	in
mil	0.0254	mm
Miles (nautical)	1.1508	miles (statute)
Miles (nautical)	6,076	ft
Miles (statute)	160,900	cm
Miles	5280	ft
Miles	1.609	km
Miles	1760	yards
Miles per hour (mph)	1.467	ft/sec
mph	88	ft/mine
mph	1.61	km/hr
mph	0.447	m/sec
mg/kg	1	parts per million (ppm)
Milliequivalents per liter (meq/L)	1	millimoles per liter (mmol/L)
Milliequivalents per 100 g (meq/100g)	Eq. wt. x 10	parts per million (ppm)
Millimhos per centimeter (mmhos/cm)	1	decisiemens per meter (dS/m)

Metric Conversion

To Convert	Multiply by	To Obtain
mmhos/cm	1,000	micromhos per centimeter (μmhos/cm)
Milliliters (ml)	0.0338	oz (fluid)
ml	0.0002642	gal
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	in
1 mm Hg @ 0 C	0.13332	kPa
1 mm Hg	133333.3	mPa
Ounces (fluid) (oz)	0.02957	L
Ounces (fluid)	29.573	ml
Ounces (fluid)	0.03125	qt
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	g
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) (pt)	0.473	liter
pt	473	ml
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

Metric Conversion

To Convert	Multiply by	To Obtain
PPM	2.0	lb/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	oz/100 gal of water
PPM	0.3295	gal/acre-foot of water
PPM	8.2897	lb/million gal of water
Pounds (lb)	0.4536	kilograms (kg)
lb	453.6	g
lb/acre	1,120	g/ha
lb/acre	1.12	kg/ha
lb/acre	1.0413	g/100 ft^2
lb/ acre	0.02296	lb/1,000 ft^2
lb/acre	0.112	g/m^2
lb/acre-foot	0.3682	g/m^3
lb/acre-foot	0.0003682	kg/m^3
lb/ft^2	4883	g/m^2
lb/ft^3	16.02	kg/m^3
lb/1,000 ft^2	4.88	g/m^2
lb/1,000 ft^2	48.83	kg/ha
lb/1,000 ft^2	43.5597	lb/A
lb/1,000 ft^2	488	g/100 m^2
lb/1,000 ft^2	0.4883	kg/100 m^2
lb/1,000 ft^2	0.91	lb/100 yd^2
lb/1,000 ft^2	1.1	lb/1,000 ft^2
lb/yd^3	0.0005937	g/cm^3
lb/yd^3	594	g/m^3
lb/yd^3	0.5932	kg/m^3
lb/gallon	0.12	kg/liter
lb/1,000 gal	0.12	g/1,000 L

Metric Conversion

To Convert	Multiply by	To Obtain
pounds per square inch (PSI)	6.89	kilopascals (kPa)
PSI	0.06895	bar
PSI	0.068046	atmosphere (atm)
PSI	2.31	feet head of water
Quarts (qt)	0.9463	L
Quarts	946	ml
Qt/A	2.3385	L/ha
Qt/A	0.7346	oz/1,000 ft^2
Qt/100 gal	2.5	ml/L
Temperature, °C + 17.98	1.8	temperature, °F
Temperature, °F - 32	0.5555	temperature, °C
Ton (2,000 lb)	907	kg
Ton (2,000 lb)/acre	2240	kg/ha
Ton (2,000 lb)	0.907	ton (metric)
Ton (2,000 lb)/acre	2.241	ton (metric)/ha
Ton (metric)	2,205	lb
Ton (metric)	1,000	kg
Ton (metric)	1.102	ton (2,000 lb)
Yards (yd)	91.44	cm
Yards	0.9144	m
Yards	914.4	mm
square yards (yd^2)	0.836	m^2
yd^2	9	ft^2
yd^2	1,296	in^2
cubic yards (yd^3)	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

Metric Conversion

To Convert	Multiply by	To Obtain
CaO	0.715	Ca
MgO	0.602	Mg
meq Ca^{+2}/100 g soil	400	lb Ca^{+2}/acre furrow slice
meq K^{+}/100 g soil	780	lb K^{+}/acre furrow slice
meq Na^{+}/100 g soil	460	lb Na^{+}/acre furrow slice
meq Mg^{+2}/100 g soil	109	lb Mg^{+2}/acre furrow slice
meq Fe^{+3}/100 g soil	372	lb Fe^{+3}/acre furrow slice
meq Zn^{+2}/100 g soil	654	lb Zn^{+2}/acre furrow slice
meq H^{+}/100 g soil	20	lb H^{+}/acre furrow slice
meq Al^{+3}/100 g soil	180	lb Al^{+3}/acre furrow slice
meq Ca^{+2}/100 g soil	9.2	lb Ca^{+2}/1,000 ft^2 furrow slice
meq K^{+}/100 g soil	18	lb K^{+}/1,000 ft^2 furrow slice
meq Na^{+}/100 g soil	10.6	lb Na^{+}/1,000 ft^2 furrow slice
meq Mg^{+2}/100 g soil	2.5	lb Mg^{+2}/1,000 ft^2 furrow slice
meq Fe^{+3}/100 g soil	8.5	lb Fe^{+3}/1,000 ft^2 furrow slice
meq Zn^{+2}/100 g soil	15	lb Zn^{+2}/1,000 ft^2 furrow slice
meq H^{+}/100 g soil	0.46	lb H^{+}/1,000 ft^2 furrow slice
meq Al^{+3}/100 g soil	4.1	lb Al^{+3}/1,000 ft^2 furrow slice