

EC 699



2002 Pest Control Recommendations for Professional Turfgrass Managers

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This publication is also available at: www.clemson.edu/turforamental/



2002 Clemson University Pest Control Recommendations for Professional Turfgrass Managers

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Clemson University Turf 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. This guide is also available on the world wide web at: <http://hubcap.clemson.edu/scafrs/hort/index.htm>

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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Poison Centers (anywhere): 1-800-222-1222

National Pesticide Information Center: 1-800-858-7378

For a pesticide chemical emergency or for any pesticide information, call NPIC toll free, day or night

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

CLEMSON UNIVERSITY TURFGRASS PUBLICATION ORDER INFORMATION

Designing and Maintaining Bermudagrass Sports Fields in the United States - EC 698

Weeds of Southern Turfgrasses - EB 150

Diseases of Turfgrasses in the Southeast - EB 146

Pest Management Handbook (vol. 2), Turfgrass and Ornamentals - EC 695

Sod Production in the Southern United States - EC 702

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://virtual.clemson.edu/groups/agcomm/pubs/pages/pubs.htm>

Send with this order form to: **Clemson University Cooperative Extension Service
Bulletin Room, Room 82
Poole Agricultural Center
Clemson, SC 29634-0311
864-656-3261**

Other Turfgrass Publications

Common Turfgrass Weeds - 84 slide set with narrative of the most common weeds in golf courses, home lawns, sports fields, and roadsides.
Sports Field Construction - 70 slide set with narrative on designing, constructing, and maintaining all levels of sports fields including baseball, football, and soccer.

These slide set are available from: CSSA Headquarters Office, Attn: Book Order Dept., 677 South Segoe Road, Madison, WI 53711-1086, <http://www.crops.org>

BOOKS

Best Golf Course Management Practices A complete text covering all agronomic practices which provide an environmentally friendly managed golf course with minimum fertilizer and pesticide inputs. Order from www.prenhall.com; Amazon.com; or BarnesandNoble.com. **ISBN 0-13-088359-X.**

Color Atlas of Turfgrass Weeds A complete text covering all major weeds occurring in Turfgrass and Ornamentals. Included are detailed biology, reproductive means, distribution ranges and control recommendations.

Managing Bermudagrass Turf A complete text concerning Bermudagrass Turf, especially golf greens. **ISBN 1-57504-163-4.**
 Order these two from Ann Arbor Press, 310 North Main Street, PO Box 20, Chelsea, MI 48118; 1-800-487-2323, www.sleepingbearpress.com.

POISON CENTERS

Robert G. Bellinger, PhD
Extension Pesticide Coordinator

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

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

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

National Pesticide Information Center (NPIC): 1-800-858-7378

For a pesticide chemical emergency or for any pesticide information.

E-mail: nptn@ace.prst.edu World Wide Web: <http://ace.orst.edu/info/nptn/index.html>

For larger pesticide spills, CHEMTREC: 1-800-424-9300

Chemical Transportation Emergency Center (English and Spanish); <http://www.chemtrec.com/>

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

Application Date: _____

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PESTICIDE APPLICATION RECORD

Company Name _____ Commercial Applicator _____ License Number _____
Pesticide License Category _____ Trade Name _____ Active Ingredient & Formulation _____
% Active Concentration _____ Manufacturer _____ Lot No. _____ EPA Registration No. _____
Restricted-entry Interval (REI) _____ Safety Equipment Needed/Worn _____

APPLICATION INFORMATION

Application Time _____ Treated Site Location _____ Type of Area Treated _____
Target Pest(s) _____ Total Treated Area _____ Application Rate (e.g., per acre or per 1000 sq. ft.) _____
Timing _____ Amount of Pesticide Product Mixed _____ Per _____ Gallons of Water: Gallon Per Acre (GPA) _____
Additives (Surfactant/Wetting Agent/Crop Oil, etc.) _____ Rate _____

WEATHER CONDITIONS

Air Temperature (°F) _____ Relative Humidity (%) _____ Dew Present (Y/N) _____ Initial Wind Velocity (MPH) _____
Wind Direction _____ First Hour _____ Second Hour _____ Third Hour _____ Soil Temperature at 4 inches (F) _____
Soil Moisture _____ Cloud Cover (%) _____ Rainfall/Irrigation after application (date/time/amount) _____

APPLICATION EQUIPMENT

Method of Application _____ Speed (mph) _____ Motor Speed (RPM) _____ Nozzle Type _____ Number _____
Nozzle Height _____ Spacing _____ Boom Width _____ Spray Pressure (PSI) _____
Nontarget Plant, Animal, or Human Exposure: Yes ___ No ___ (If yes, identify and list corrective or emergency action taken) _____

Other Comments:

Signature _____

Date _____

INSECT CONTROL

Clyde S. Gorsuch
Extension Entomologist

There are many insects that can be found in a turf area. Fortunately, only a few are of major importance. Common turfgrass pests in South Carolina, which suck plant tissues, include chinch bugs, spittlebugs, and bermudagrass mites. Others, such as the mole crickets, white grubs, and billbugs feed on plant roots and are equally damaging. Sod webworms, armyworms, and other lawn caterpillars damage turfgrass by eating grass leaves. Another group of insects and related pests are found but cause no damage. They are more of a nuisance because they bite or sting or migrate into houses, swimming pools, etc. These include ants, fleas, ticks, millipedes, chiggers, sowbugs, and snails.

Insects are only one of the many causes of thinning out or off color areas in grass. Diseases, nematodes, dry weather, and nutritional disorders are frequently responsible for such injury. Correctly identify the problem before recommending a treatment. Pesticide applications to control chinch bugs, sod webworms, and armyworms can be reduced by following certain management practices.

Monitoring: Every week to ten days during the season, inspect the turf for pests.

To check for chinch bugs: Insert a metal can with both ends cut out into the turf in an area where the grass is yellowed and declining. Fill the can with water. Wait 5 minutes for chinch bugs to float to top of water. If none are present, examine at least 3 to 4 places in the suspected area. Sample areas along the margin of the damaged area as well. Also, part the grass and observe the soil surface in the yellowed areas for all stages of the chinch bug.

Mole crickets, sod webworms, cutworms, armyworms, other lawn caterpillars: Mix 2 - 4 fl. oz. of dishwashing detergent in two gallons of water and drench a four square foot area with the solution. Insects will emerge to the soil surface if present. If none are found, examine other suspected areas and repeat.

Billbugs and white grubs: With a spade, cut three sides of a one foot square piece of sod to a depth of two inches at the edge of one of the off-color areas in the turf. Lay back the sod and examine roots for chewed off remnants and check soil for larvae. If 3 - 4 grubs or billbugs per square foot are found, apply an insecticide.

Cultural Practices: Avoid using excessive nitrogen fertilizers, particularly highly water soluble sources. These increase the succulence of the turf and encourage increases in insect attacks. Use slow release nitrogen when possible. Mow properly, follow the $\frac{2}{3}$ height rule. This involves mowing the grass once it grows to a height $\frac{2}{3}$ higher than what it is normally maintained. Avoid thatch and remove when excessive.

SPECIAL NOTE: Diazinon has been removed from the recommendations due to its ongoing phase out. It is still legal to use diazinon, but do not stockpile material. A diazinon recovery program will occur in 2004 to complete the phase out. Do not use diazinon products on golf courses or sod farms.

INSECT PEST CHEMICAL CONTROLS			
Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Armyworms	Astro	0.4 to 0.8 fl oz	Fall armyworm populations fluctuate greatly from season to season. High populations will migrate across an area and destroy the grass. A detergent flush consisting of 1 to 2 fl oz detergent per gallon of water, will aid in detecting low populations and small larvae. Treat when larvae and damage are apparent. For best results, delay mowing or irrigation for 24 hours after application. Dursban for use on golf courses, road medians, and industrial plants sites only.
	<i>Bacillus thuringiensis</i> (Dipel DF, 2X; Biobit HP; Javelin WG; XenTari)	See Label	
	Scimitar GC or CS, Battle GC T&O	3.4 to 7 ml	
	Conserve SC	0.25 to 1.2 fl oz	
	Dursban PRO	1.5 fl oz	
	Mach 2 Liquid	1.5 fl oz	
	Mach 2 Granular	1.55 fl oz	
	Orthene Turf, Tree & Ornamental Spray; Address T/O;	0.5 to 1.2 oz	
	Sevin 10G	1.4 to 1.9 lbs	
	Sevin 80WSP	2.5 to 5 lb/acre	
	Sevin SL	1.5 to 3 fl oz	Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.
	Suspend SC	0.4 to 0.6 fl oz	
	Talstar Flowable	0.23 to 0.46 oz	
	Talstar Nursery Flowable	0.23 to 0.46 oz	
	Talstar Lawn & Tree Flowable	0.23 to 0.46 oz	
	Talstar GC or PL Granular	1.15 lbs	
	Talstar GC Flowable	0.23 to 0.46 oz	
	Tempo 2	4 to 6 ml	
	Tempo 20 WP	5 to 10 grams	
	Tempo 20 WP GC	55 grams/11,000 sq ft	
Billbugs	Turcam 2.5G	0.9 to 1.9 lb	Billbug adults and larvae feed on the roots and stems of various turfgrasses. Adults can be forced from the grass with a detergent flush consisting of 1 to 2 fl oz liquid detergent per gallon of water. Larvae can be detected by cutting squares of sod and observing the root area for grubs. Treat when adults and/or larvae are found and damage is apparent. Most materials should be watered-in with ½-inch immediately after application. See label directions. Dursban for use on golf courses, road medians, and industrial plants sites only.
	Turplex Bioinsecticide	0.25 to 0.5 fl oz	
	Scimitar GC or CS or Battle GC T&O	7 ml	
	DeltaGard GC or T&O 5SC	0.6 to 0.9 fl oz	
	DeltaGard GC or T&O Granules	2 to 3 lbs	
	Dursban PRO	1.5 fl oz	
	Mach 2 Liquid	2.2 fl oz	
	Mach 2 Granular	2.3 lbs	
	Merit 75WP	4.2 to 5.6 grams	
	Merit 0.5 G	1.4 to 1.8 lbs	
	Sevin 10G	1.9 lbs	
	Sevin 80WSP	10 lb/acre	
	Sevin SL	6 fl oz	
	Suspend SC	0.6 to 0.9 fl oz	
	Talstar Flowable	0.25 to 0.5 fl oz	
	Talstar Nursery Flowable	0.25 to 0.5 fl oz	
	Talstar Lawn & Tree Flowable	0.25 to 0.5 fl oz	Suspend is for adult billbugs only. Talstar is for adult billbug control only.
	Talstar PL Granular	1.15 to 2.3 lbs	
	Talstar GC Granular	1.15 to 2.3 lbs	
	Talstar GC Flowable	0.25 to 0.5 oz	

INSECT PEST CHEMICAL CONTROLS			
Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Chinch Bugs	Astro Scimitar GC or CS Dursban PRO Orthene Turf, Tree & Ornamental Spray Sevin 10G Sevin 80 WSP Sevin SL Suspend SC Talstar Flowable Talstar GC Flowable Talstar Lawn & Tree Flowable Talstar PL Granular Tempo 2 Tempo 20 WP Tempo 20 WP GC Turcam 2.5G	0.4 to 0.8 fl oz 7 ml 1.5 fl oz 1.2 to 2.4 oz 1.4 to 1.9 lbs 7.5 to 10 lb/acre 4.4 to 6 fl oz 0.6 to 0.9 fl oz 0.23 to 0.46 oz 0.23 to 0.46 oz 0.23 to 0.46 oz 2.3 to 4.6 lbs 6 ml 10 grams 55 grams/7,800 sq ft 0.9-1.9 lbs	<p>Chinch bugs are a major problem on St. Augustinegrass. Hot, dry weather, deep thatch, and high fertility favor chinch bug development. A metal cylinder, open at both ends, driven into the soil and filled with water can be used for sampling. Adults and nymphs will float to the surface within 10 minutes. Treatments should be applied if 25 to 30 insects are found per square foot. Use a minimum spray volume of 50 gallons/acre (1.2 gallons/1000 sq. ft.). If organophosphate insecticides are not providing control, use Scimitar, or Tempo. Plant 'Floritam' or 'Floralawn' St. Augustinegrass varieties. Cultural controls include less N, using water insoluble (slow release) N, using a sharp mower blade, mowing at 3" in sun areas, 4" in shaded areas, and controlling thatch. Irrigate with ¾ inch when grass begins to wilt. Minimize the use of atrazine on St. Augustinegrass during summer. Monitor turf regularly. To preserve beneficial arthropods, spot treat the damaged area and 5 to 10 feet beyond. Recheck in 2-3 days. Spot treat again, if needed.</p> <p>Dursban for use on golf courses, road medians, and industrial plants sites only.</p> <p>Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet.</p>

INSECT PEST CHEMICAL CONTROLS			
Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Cutworms	Astro	0.4 to 0.8 fl oz	Cutworm larvae usually spend the day in burrows. A detergent flush consisting of 1 fl oz liquid detergent per gallon of water, can be used to sample larvae. Treatments should be applied when damage and larvae are present. Late afternoon applications are most effective. Most materials should be watered-in with ½-inch immediately after application. See label directions. Dursban for use on golf courses, road medians, and industrial plants sites only.
	<i>Bacillus thuringiensis</i> (Dipel DF, Javelin WG, XenTari)	See Label	
	Scimitar GC or CS	3.4 to 7 ml	
	Conserve SC	0.8 to 1.2 fl oz	
	DeltaGard GC or T&O SSC	0.4 to 0.6 fl oz	
	DeltaGard GC or T&O Granules	2 to 3 lbs	
	Dursban PRO	1.5 fl oz	
	Dylox 6.2G	2 lbs	
	Advanced Lawn 24 Hour Grub Control		
	Mach 2 Granular	1.55 lb	
	Mach 2 Liquid	1.5 fl oz	
	Merit 75WP	4.2 to 5.6 grams	
	Merit 0.5 G	1.4 to 1.8 lbs	
	Orthene Turf, Tree & Ornamental Spray	1.2 to 2.4 oz	
	Sevin 10G	0.9 lbs	
	Sevin 80 WSP	2.5 to 5 lb/acre	
	Sevin SL	1.5 to 3 fl oz	
	Suspend SC	0.4 to 0.6 fl oz	
	Talstar Flowable	0.23 to 0.46 oz	
	Talstar GC Flowable	0.23 to 0.46 oz	
	Talstar GC or PL Granular	1.15 lbs	
	Talstar Lawn & Tree Flowable	0.23 to 0.46 oz	
Ground Pearls	Tempo 2	4 to 6 ml	Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet.
	Tempo 20 WP	5 to 10 grams	
Ground Pearls	Tempo 20 WP GC	55 grams/11,000 sq ft	This scale insect feeds on the roots of bermudagrass, St. Augustinegrass, zoysiagrass, and centipedegrass. All stages occur on roots. Most of the stages are well-protected in a pearl-like cyst. Follow proper cultural practices including proper fertilization, mowing heights, and irrigation to grow healthy turf.
	Turplex Bioinsecticide	0.25 to 0.5 fl oz	
	White Grub & Sod Webworm Insecticide	2 lbs	

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Mites: Bermudagrass & Clover	Dursban Pro Kelthane T/O Talstar GC Flowable Talstar Lawn & Tree Flowable	1.5 fl oz 0.5 to 1 lb per acre 0.25 to 0.5 fl oz 0.25 to 0.5 fl oz	<p>Clover mites are a problem in spring and fall. Feeding causes a silvery discoloration of grass. Damage is usually near the house foundation. Bermudagrass mites are a problem on common bermudagrass during hot, dry weather. Feeding causes yellowing and distortion of the grass. Newer, hybrid bermudagrasses are resistant to this pest. Apply controls when damage is apparent. A wetting agent in the spray mixture improves results. Apply a second in 10-14 days. Cultural controls include collecting grass. Reduce mowing height as close as practical if mites are a problem.</p> <p>Dursban for use on golf courses, road medians, and industrial plants sites only.</p> <p>Talstar is labeled only for clover mite control.</p>

INSECT PEST CHEMICAL CONTROLS			
Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Mole Crickets	Scimitar CS or GC or Battle GC	7 - 14 ml	Mole cricket adults are present during later winter and early spring. Mating flights occur from April through June. Egg hatch occurs from mid-June through July. The Tawny Mole Cricket is a much more serious problem than the Southern Mole Cricket. Treatment in the early spring is probably beneficial. This reduces the number of mole crickets laying eggs. Treatment of small nymphs in late June and July is highly recommended.
	Chipco Choice 0.1% G ²	12½ to 25 lbs/A	
	Chipco TopChoice	2 lbs	
	DeltaGard GC or T&O 5SC	0.6 to 0.9 fl oz	To detect mole crickets use a detergent flush consisting of 1 to 2 fl oz liquid detergent per gallon of water. One gallon will flush a 4 sq. ft. area. Treat when mole crickets and damage are present. Small nymphs will cause little detectable damage, but should be treated when present. Soil should be moist at time of treatment. Irrigate sprays or granulars into soil with ½" of water, except Orthene and baits. A surfactant may increase efficacy of Orthene. Apply all pesticides as late in the day as possible. Where a range of rates are given, use the high rate for adult mole cricket control. Cultural controls include not mowing turf shorter than recommended heights. Use a sharp mower blade. Irrigate turf when wilting begins with ¾ inch water. Maintain proper fertility and pH levels. Sprays and granules should be applied during mid to late June. Application of baits and Orthene should be made when damage first appears (early- to mid-July). Insecticides can be applied later in the year, (Aug.-Oct.) but more damage will have occurred and the crickets are more difficult to control. Irrigate after applying sprays or granules with ½ inch water (except Orthene). Apply as late as possible in late afternoon. Do not irrigate after application of baits for 2-3 days if possible. If soil is not moist, it is important to irrigate before applying sprays, granules and baits.
	DeltaGard GC or T&O Granules	2 to 3 lbs	
	Dylox 6.2 G	3 lbs	
	Advanced Lawn 24 Hour Grub Control	5.6 grams	
	Merit 75WP	1.8 lbs	
	Merit 0.5G	3.8 lbs	
	Advanced Lawn Season-Long Grub Control	1 to 1.9 oz	
	Orthene Turf, Tree & Ornamental Spray	0.45 to 0.75 lb	
	Pinpoint 15G	See Label	
	Sevin Baits	0.6 to 0.9 fl oz	
	Suspend SC	0.5 to 1 fl oz	
	Talstar Flowable	2.3 to 4.6 lbs	
	Talstar GC Granular	0.5 to 1 fl oz	
	Talstar GC Flowable	0.5 to 1 fl oz	
	Talstar Lawn & Tree Flowable	2.3 to 4.6 lbs	
	Talstar PL Granular	6 ml	
	Talstar GC Mole Cricket Bait	10 grams	
	Tempo 2	2.3 - 4.6 lbs	
	Tempo 20 WP	55 grams/7,800 sq ft	Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet. Triad can be used on a trial basis where traditional insecticides are not applicable. Turcam 2.5G rates may be reduced (see label) if slit application is used
	Tempo 20 WP GC	2 lbs	
	Triad Granular Bait	1.9 to 2.8 lbs	
	Turcam 2.5 G	3 lbs	
	White Grub & Sod Webworm Insecticide		

INSECT PEST CHEMICAL CONTROLS			
Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
Sod Webworms	Astro	0.4 to 0.8 fl oz	Sod webworm adult moths have a characteristic snout-like projection in front of their heads. They fly over the grass in the evening. Larvae can be forced from the grass with a detergent flush consisting of 1 fl oz liquid detergent per gallon of water which will cover a 4 sq. ft. area. Treatments should be applied when damage and larvae are present. Most materials should be watered-in immediately after application.
	<i>Bacillus thuringiensis</i> (Dipel DF, Javelin WG, XenTari)	See label	
	Scimitar GC or CS	3.4 to 7 ml	
	Conserve SC	0.25 fl oz	
	DeltaGard GC or T&O 5SC	0.4 to 0.6 fl oz	
	Dursban PRO	1.5 fl oz	
	Dylox 6.2G	2 lbs	Dursban for use on golf courses, road medians, and industrial plants sites only.
	Advanced Lawn 24 Hour Grub Control	1.55 lbs	
	Mach 2 Granular	1.5 fl oz	
	Mach 2 Liquid	0.5 to 1.2 oz	
	Orthene Turf, Tree & Ornamental Spray	1.4 to 1.9 lbs	
	Sevin 10G	7.5 to 10 lbs/acre	
	Sevin 80WSP	4.4 to 6 fl oz	
	Sevin SL	0.4 to 0.6 fl oz	
	Suspend SC	0.23 to 0.46 oz	
	Talstar Flowable	1.15 lbs	
	Talstar GC Granular	0.25 fl oz	
	Talstar GC Flowable	0.23 to 0.46 oz	
	Talstar Lawn & Tree Flowable	1.15 lbs	
	Talstar PL Granular	4 to 6 ml	
	Tempo 2	5 to 10 grams	
	Tempo 20WP	55 grams/11,000 sq ft	
	Tempo 20WP GC	0.25 to 0.5 fl oz	Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.
	Turplex Bioinsecticide	0.9 to 1.9 lbs	
	Turcam 2.5G	2 lbs	
	White Grub & Sod Webworm Insecticide		
Spittlebugs	Orthene Turf Tree & Ornamental Spray	1 to 1.9 oz	Spittlebugs are a sporadic problem, primarily on centipedegrass. High mowing height and thatch buildup aggravate the problem. Nymphs are found at the base of the grass plant. The nymphs are enclosed in a white, foamy, spittle mass. Feeding causes yellowing of the grass. Treat when nymphs are present and damage appears. Use a minimum of 50 gallons of water per acre (1.2 gallons/1000 sq. ft.). Mow and irrigate before treatment.
	Sevin 10 G	1.4 to 1.9 lbs	
	Sevin 80WSP	See label	
	Sevin SL	1½ to 3 fl oz	

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Amount of Formulation For 1,000 Sq. Ft.	Cultural Practices and Comments
White Grubs	Advanced Lawn Season-Long Grub Control	2.87 lbs	May and June beetle, green June beetle, masked chafer, and Japanese beetle larvae are all grouped under white grubs. To detect grubs, remove 1 sq. ft. of sod and carefully inspect the root zone. In most cases, if more than 7 grubs are found per sq. ft., treatment is needed. Apply treatment when grubs are small and feeding near the surface in late August and September. Most materials should be watered-in immediately with ½-inch after application. See label directions.
	Dylox 6.2 G	3 lb	
	Advanced Lawn 24 Hour Grub Control		
	Mach 2 Liquid	2.2 fl oz	
	Mach 2 Granular	2.3 lbs	
	Merit 75WP	4.2 to 5.6 grams	
	Merit 0.5G	1.4 to 1.8 lbs	
	Milky Spore Disease	See label	
	Sevin 10G	1.9 lbs	
	Sevin 80WSP	10 lb/acre	
	Sevin SL	6 fl oz	
	Turcam 2.5 G	1.9 to 2.8 lbs	
	White Grub & Sod Webworm Insecticide	3 lbs	Milky Spore Disease is primarily for Japanese beetle grubs. Turcam 2.5G rates may be reduced (see label) if subsurface slit application is used

Comparison of Insecticides Registered for Mole Cricket Control in Turf.

Material	Formulation	Residual	Commercial Use	Residential Use	Comment
Chipco Choice*	0.1%G	very long	yes	no	Slit applications only. Caution use label.
Chipco TopChoice	0.0143%G	long	yes	yes	Broadcast application, 4 months control
Turcam	2.5G	long	yes	yes	
Merit	75WP, 0.5G	intermediate	yes	yes	Several formulations for various sites.
Advanced Lawn Season Long Grub Control	0.2G	intermediate		yes	Best for nymphs, apply at egg hatch.
Scimitar	0.88 EC	intermediate	yes	yes	Best for nymphs, apply at egg hatch.
Advanced Lawn 24 Hour Grub Control	6.2G	intermediate		yes	Low odor; controls nymphs and adults
Orthene, Pinpoint, Velocity**	75, 15G	short	yes	yes	Standard for nymphs in summer.
Baits					
Sevin**	5%	short	yes	yes	Good for mid- and late season nymphs.

*Not effective on white grubs.

Nuisance Pests - Chemical Controls			
PEST	PESTICIDE FORMULATION ¹	AMOUNT OF FORMULATIONS FOR 1,000 sq. ft.	Cultural Practices and Comments
Ants	Astro	0.4 to 0.8 fl oz	Common ants may become a nuisance in some cases. Treat when the ants can not be tolerated.
	Scimitar GC or CS	3.4 to 7 fl oz	
	DeltaGard GC or T&O 5SC	0.4 to 0.6 fl oz	NOTE: 5% Malathion or 5% Sevin dust may also be used for ant control.
	DeltaGard GC or T&O Granules	2 to 3 lbs	
	Dursban Pro	1.5 fl oz	Dursban for use on golf courses, road medians, and industrial plants sites only.
	Orthene Turf, Tree & Ornamental	1.6 oz/gal	
	Pinpoint	See label	Use Orthene as a spot treatment for ants.
	Sevin 10G	1.4 to 1.9 lbs	
	Sevin 80WSP	2.5 to 5 lbs	
	Sevin SL	1.5 to 3 fl oz	
	Suspend SC	0.4 to 0.6 fl oz	
	Talstar Flowable	0.23 to 0.46 oz	
	Talstar GC Flowable	0.23 to 0.46 oz	
	Talstar GC Granular	2.3 to 4.6 lbs	
	Talstar Lawn & Tree Flowable	0.23 to 0.46 oz	
	Talstar Nursery Flowable	0.23 to 0.46 oz	
	Tempo 2	4 to 6 ml	
	Tempo 20WP	5 to 10 grams	
	Tempo 20WP GC	55 grams/11,000 sq ft	
	Turcam 2.5G	0.9 to 1.9 lbs	
Velocity	See label	Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.	

NUISANCE PESTS - CHEMICAL CONTROLS			
PEST	PESTICIDE FORMULATION ¹	AMOUNT OF FORMULATIONS FOR 1,000 sq. ft.	Cultural Practices and Comments
Imported Fire Ants	Advanced Lawn Fire Ant Killer	Mound Treatment	Management of imported fire ants requires a long term commitment. Three methods of management are available: Individual mound treatments; broadcast bait treatments and broadcast insecticide treatments.
	Battle GC/Scimitar GC or CS	See label	Mound treatments (e.g., liquid drenches or granules) are fairly fast acting, but will require follow-up treatment to kill ants in local areas. If the queen is not killed during the initial treatment, surviving workers will move the queen to a new location. Ants will fly into an area and establish new colonies.
	Deltagard	See label	Broadcast bait treatments are more effective in reducing the population in an area. They are slower acting and no results will be noticed for three or four weeks. Baits will most likely need to be applied in the spring and fall.
	Dursban Pro	See label	Broadcast insecticide treatments are recommended in high risk areas. Repeated applications may be needed to maintain control. This method can be combined with individual mound treatment and broadcast bait treatments.
	Orthene Turf, Tree & Ornamental	See label	The Two-Step Program is recommended for large turfgrass areas. Treat with a bait in the spring. After a week, spot treat mounds in high traffic and other problem areas with an individual mound treatment. Spot treat mounds as needed. Apply another bait application in the fall.
	Pinpoint or Velocity	See label	Dursban for use on golf courses, road medians, and industrial plants sites only.
	Sevin 80 WSP, SL	See label	Commercial sod and nursery producers should be familiar with Plant Quarantine Regulations and Certification requirements to help minimize the spread of ants to non-infested areas.
	Talstar	See label	
	Tempo	See label	
	Amdro Bait	Broadcast Baits	
	Amdro Granular	See label	
	Award Fire Bait	See label	
	Chipco FireStar Fire Ant Bait	See label	
	Distance Fire Ant Bait	See label	
	Justice Fire Ant Bait	See label	
	Siege Fire Ant Bait	See label	
	Varsity Fire Ant Bait	See label	
	Battle GC/Scimitar GC or CS	Broadcast Insecticide	
	Chipco TopChoice	3.4 - 7 ml	
	Talstar	2 lbs	
		1 fl oz	
Millipedes Centipedes Sowbugs	Astro	0.4 to 0.8 fl oz	These are nuisance pests that commonly enter homes. Treat around the perimeter of the house. Follow specific label directions for each pesticide.
	Battle GC or Scimitar GC or CS	3.4 to 7 ml	Dursban for use on golf courses, road medians, and industrial plants sites only.
	Dursban Pro	1.5 fl oz	
	Sevin SL	1.5 to 3 fl oz	
	Sevin 80WSP	2.5 to 5 lbs	
	Suspend SC	0.4 to 0.6 fl oz	
	Talstar Flowable	0.23 to 0.46 oz	
	Talstar GC Flowable	0.23 to 0.46 oz	
	Talstar GC Granular	4.6 lbs	
	Talstar Lawn & Tree Flowable	0.25 to 0.5 fl oz	
	Talstar Nursery Flowable	0.23 to 0.46 oz	
	Turcam 2 ½ G	0.9 to 1.9 lbs	

NUISANCE PESTS - CHEMICAL CONTROLS			
PEST	PESTICIDE FORMULATION ¹	AMOUNT OF FORMULATIONS FOR 1,000 sq. ft.	Cultural Practices and Comments
Snails Slugs	Deadline Granules Metaldehyde 7.5G	0.5 to 2 lbs 6.4 oz	For best results, apply in evening following rain or irrigation. Water infested area thoroughly before application. Do not re-water for 48 hours.
Chiggers (Red Bugs), Ticks	Astro Scimitar GC or CS DeltaGard GC 5SC DeltaGard GC or G Granules Dursban Pro Sevin 10G Sevin SL Suspend SC Talstar GC Flowable Turcam 2 ½ G	0.4 to 0.8 fl oz 3.4 to 7 ml 0.4 to 0.6 fl oz 2 to 3 lbs 1.5 fl oz 1.6 to 1.9 lbs 1.5 to 3 fl oz 0.4 to 0.6 fl oz 0.5 fl oz 0.9 to 1.9 lbs	Chiggers (red bugs) and ticks may be present in turfgrass areas. Apply controls as needed. Follow label directions. Astro, Scimitar GC, and Turcam are only for tick control. Dursban for use on golf courses, road medians, and industrial plants sites only. Turcam 2 ½ G is labeled for ticks only.
Fleas	Astro Scimitar GC or CS Dursban Pro Orthene Turf, Tree & Ornamental Suspend SC Talstar GC Flowable Talstar GC and PL Granular Talstar Lawn & Tree Flowable	0.4 to 0.8 fl oz 3.4 to 7 ml 1.5 fl oz 1.2 to 2.4 oz 0.4 to 0.6 fl oz 0.23 to 0.46 oz 2.3 to 4.6 lbs 0.5 fl oz	Fleas may be resident in turf areas. Area treatment as needed will reduce populations. Pets need to be treated as well. Dursban for use on golf courses, road medians, and industrial plants sites only.
Wasps Bees	Orthene Turf, Tree, & Ornamental Spray Talstar GC and Lawn & Tree Flowable	1.6 oz/gal water 0.5 fl oz/gal water	Soil nesting bees and wasps should be treated late in the evening when foraging adults have returned to the nest. Thoroughly spray the entrance to the nest.

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

²Not labeled for lawns (domestic turf).

Cross reference table of insecticides for major turfgrass pests.

Insecticide	Armyworm	Bermudagrass Mites	Billbugs	Clover Mites	Cutworms	Fire Ants	Leafhoppers	Mole Crickets	Sod Webworm	Southern Chinch Bug	Spittlebugs	White Grubs
Advanced Lawn 24 Hour Grub Control					✓			✓	✓			✓
Advanced Lawn Season-Long Grub Control								✓				✓
Amdro Bait/Amdro Granular Insecticide						✓						
Astro	✓					✓	✓		✓	✓		✓
Award Fire Ant Bait						✓						
<i>Bacillus thuringiensis</i> (Dipel, Javelin, XenTari)	✓				✓				✓			
Chipco Choice								✓				
Chipco TopChoice						✓		✓				
Chipco FireStar						✓						
Conserve SC	✓				✓				✓			
DeltaGard	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Distance Fire Ant Bait						✓						
Dursban PRO	✓	✓	✓	✓	✓	✓	✓		✓	✓		
Dylox					✓			✓	✓			✓
Kelthane		✓		✓								
Mach 2	✓		✓		✓				✓			✓
Merit 75WP, 0.5G			✓		✓			✓				✓

Cross reference table of insecticides for major turfgrass pests. (continued)

Insecticide	Armyworm	Bermudagrass Mites	Billbugs	Clover Mites	Cutworms	Fire Ants	Leafhoppers	Mole Crickets	Sod Webworm	Southern Chinch Bug	Spittlebugs	White Grubs
Orthene TT&O	✓				✓	✓	✓	✓	✓	✓	✓	
Pinpoint 15G						✓		✓				
Scimitar GC or CS / Battle GC	✓		✓		✓	✓	✓	✓	✓	✓		
Seige Fire Ant Bait						✓						
Sevin 10G	✓		✓		✓	✓	✓		✓	✓	✓	✓
Sevin 80 WSP	✓		✓		✓	✓	✓			✓	✓	✓
Sevin SL	✓		✓		✓	✓	✓		✓	✓	✓	✓
Suspend SC	✓		✓	✓	✓		✓	✓	✓	✓		
Talstar Flowable & Granular formulations	✓		✓		✓	✓		✓	✓	✓		
Tempo 2, 20WP, and 20WP GC	✓		✓		✓	✓		✓	✓	✓		
Turcam 2.5G							✓	✓	✓	✓		✓
Turplex Bioinsecticide	✓				✓				✓			
Varsity Fire Ant Bait						✓						
Velocity 15G						✓						
White Grub & Sod Webworm Insecticide					✓			✓	✓			✓

Cross reference table of insecticides for nuisance turfgrass pests.

Insecticide	Ants	Chiggers (Red Bugs) Ticks	Imported Fire Ants	Fleas	Centipedes Millipedes Pillbugs Sowbugs	Snails Slugs	Wasps Bees
Advanced Lawn Fire Ant Killer			✓				
Amdro Bait			✓				
Amdro Granular Insecticide	✓		✓				
Astro	✓		✓	✓	✓		✓
Award Fire Ant Bait			✓				
Chipco Topchoice	✓	✓	✓	✓			
Deadline Granules						✓	
Dursban PRO	✓	✓	✓	✓	✓		
Metaldehyde 7.5G						✓	
Orthene TT&O	✓		✓	✓		✓	
Pinpoint 15G	✓		✓				
Scimitar GC	✓	✓	✓	✓	✓	✓	
Sevin SL	✓	✓	✓	✓	✓	✓	
Talstar	✓	✓	✓	✓	✓	✓	
Tempo 2, 20WP, and 20WP GC	✓	✓	✓	✓	✓	✓	
Turcam 2.5G	✓			✓			
Velocity 15G	✓		✓				

Characteristics of insecticides labeled for use on turfgrass

Insecticide Class/Family	Insecticide common (trade) name	Mammalian Toxicity LD ₅₀ mg/kg body weight	Avian Toxicity (mallard duck) LD ₅₀ mg/kg body weight	Fish Toxicity (rainbow trout) LC ₅₀	Earthworm Toxicity	Water Solubility
Amidinohydrazone	hydramethlnon (AMDRO, SIEGE)	>5,000 mg/kg	>2,510 mg/kg	0.16 mg/l		insoluble
Bacterial	<i>Bacillus thuringiensis</i> (BIOBIT, DIPEL, JAVELIN, XENTARI)	non toxic	no affect	no affect	no affect	insoluble
Botanical	avermectin B1, B1a, B1b (AFFIRM BAIT, VARSITY)	10 mg/kg	2,000 mg/kg (quail)	3.2 ppb	28 ppm (28-day)	7.8 ppb
Botanical	azadirachtin (TURPLEX BIOINSECTICIDE)	5,000 mg/kg	no affect	0.48 ppm	no affect	
Carbamate	bendiocarb (TURCAM)	40 mg/kg	3.1 mg/kg	1.55 ppm	high	260 ppm
Carbamate	carbaryl (SEVIN)	246 mg/kg	>2179 mg/kg	1.95 ppm	high	50 ppm
Carbamate	fenoxycarb (AWARD FIRE ANT BAIT)	9,220 mg/kg	3,000 mg/kg	0.66 ppm		6 ppm
Chlorinated hydrocarbon	dicofol (KELTHANE)	570 mg/kg	3010 ppm (quail)	0.12 ppm		0.8 ppm
Chloronicotinyl	imidacloprid (MERIT)	450 mg/kg	125 mg/kg quail	211 ppm	low	580 ppm (0.58 g/l)
Halofenozide	halofenozide (MACH 2)	>5,000 mg/kg				
Hydrazone	hydramethylnon (AMDRO BAIT)	1,131 mg/kg	>2,510 mg/kg	0.16 ppm		0.006 ppm
Naturalyte	spinosyn A & D (CONSERVE)	>5,000 mg/kg	>2,000 mg/kg	30 ppm		A - 235 ppm D - 0.332 ppm
Organophosphate	acephate (ORTHENE, PINPOINT, VELOCITY)	700 mg/kg	350 mg/kg	>1,000 ppm		650,000 ppm
Organophosphate	chlorpyrifos (DURSBAN)	96 mg/kg	112 mg/kg	7.1-51 ug/l	medium	2 ppm
Organophosphate	trichlorfon (DYLOX; WHITE GRUB & SOD WEBWORM INSECTICIDE; ADVANCED LAWN 24 HOUR GRUB CONTROL)	250 mg/kg	40-47 mg/kg	3.2 ppm	medium	136,000 ppm

Characteristics of insecticides labeled for use on turfgrass (continued)

Insecticide Class/Family	Insecticide common (trade) name	Mammalian Toxicity LD₅₀ mg/kg body weight	Avian Toxicity (mallard duck) LD₅₀ mg/kg body weight	Fish Toxicity (rainbow trout) LC₅₀	Earthworm Toxicity	Water Solubility
Phenyl pyrazole	fipronil (CHIPCO CHOICE, TOPCHOICE, FIREBAN)	97 mg/kg	>2,150 mg/kg 11.3 mg/kg (quail)	0.25 ppm		1.9-2.4 ppm
Pyrethroid	bifenthrin (TALSTAR)	54.5 mg/kg	2,150 mg/kg	0.15 ppm	low	0.1 ppm
Pyrethroid	cyfluthrin (TEMPO)	291 mg/kg	>5,000 mg/kg	68 ppb 0.00068 mg/l	low	0.002 ppm
Pyrethroid	deltamethrin (DELTA GARD, SUSPEND)	>2,000 mg/kg				
Pyrethroid	lambda-cyhalothrin (BATTLE, SCIMITAR)	157-190 mg/kg				
Pyrethroid	permethrin (ASTRO)	430 mg/kg	>9,900 mg/kg	12.5 ppb		0.2 ppm
Other	pyriproxfen (DISTANCE)	>5,000 mg/kg	>2,000 mg/kg	>325 ug/l		

Turfgrass sites insecticide labels indicate they can be used. If the insecticide is labeled for turfgrass and does not prohibit use on a specific site, the insecticide can legally be used. For example, Conserve can be used to control specific pests infesting turfgrass. No specific sites are listed and none are prohibited.

Turfgrass sites insecticide labels indicate they can be used

Insecticide	Restricted Use	Golf Courses	Sod Farms	Athletic Fields	Residential Lawns	Recreational Lawns	Commercial Lawns	Parks	Cemeteries
Advanced Lawn 24 Hour Grub Control					yes				
Advanced Lawn Season-Long Grub Control					yes				
Advanced Lawn Fire Ant Killer					yes				
Amdro Bait		yes	No		yes	yes	yes	yes	
Amdro Granular Insecticide			yes		yes	yes	yes		
Astro			yes	yes	yes	yes	yes	yes	
Award Fire Ant Bait		yes	yes	yes	yes	yes	yes	yes	yes
Biobit HP									
Chipco Choice		yes	No	No	No	No	yes	No	No
Chipco Topchoice		yes	yes	yes	yes	yes	yes	yes	yes
Conserve SC									
DeltaGard G		No	No		yes	yes	yes		
DeltaGard GC 5SC	YES	yes	yes	yes	yes	yes	yes		
DeltaGard GC Granules	YES	yes	yes						
DeltaGard T&O 5SC		No	No	yes	yes	yes	yes		
DeltaGard T&O Granules		No	No						
Diazinon AG600	YES	No	No	No	yes	yes	yes		

Turfgrass sites insecticide labels indicate they can be used

Insecticide	Restricted Use	Golf Courses	Sod Farms	Athletic Fields	Residential Lawns	Recreational Lawns	Commercial Lawns	Parks	Cemeteries
Dipel 2X		yes	yes	yes	yes	yes	yes	yes	yes
Distance Fire Ant Bait		yes	yes	yes	yes	yes	yes	yes	yes
Dursban Pro	YES	yes	No	No	No	No	yes	No	No
Dylox 6.2 Granular Insecticide			No						
Javelin WG			yes						
Kelthane T/O		yes	yes	yes	No	yes	yes	yes	yes
Mach 2 Liquid		yes	yes	yes	yes	yes	yes	yes	yes
Mach 2 Granular		yes	yes	yes	No	yes	yes	yes	yes
Merit 75 WP		yes	No	yes	yes	yes	yes	yes	yes
Merit 0.5 G		yes	No	yes	yes	yes	yes	yes	yes
Orthene TT&O		yes	yes	yes	yes	yes	yes	yes	yes
Pinpoint 15 Granular				yes	yes	yes	yes		
Scimitar CS		No	No	yes	yes	yes	yes	yes	
Scimitar GC Battle GC	YES	yes	No	yes	yes	yes	yes	yes	
Sevin 10G			No	yes	yes	yes	yes		
Sevin 80 WSP		yes	yes	yes	yes	yes	yes	yes	yes
Sevin SL		yes	No	yes	yes	yes	yes	yes	yes
Siege Fire Ant Bait		yes	No	yes	yes	yes	yes	yes	
Suspend SC			No	yes	yes	yes	yes	yes	
Talstar Flowable		No		yes	yes	yes	yes		

DISEASE CONTROL
S. Bruce Martin
Extension and Research Plant Pathologist

Diseases are primary limiting factors to the successful culture of cool and warm season turfgrasses in South Carolina. The wide range of microclimates in the state allow culture of a wide variety of turfgrasses, but frequently the humid conditions allow disease development. Warm season grasses also come under stress from cold temperatures in transition zone habitats. 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.

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Anthracnose leaf blight and Anthracnose basal rot <i>(Colletotrichum graminicola)</i> All grasses	The causal fungus can infect leaves, sheaths, and tillers. In creeping bentgrass and <i>Poa annua</i> , 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 a dark, cushion-like reproductive structure (acervulus) with black spines (setae) extending from the cushion. Anthracnose basal rot may have deep-seated infections that are not readily diagnosed with only a hand lens.	Avoid stressed turf caused by consistent low mowing and rolling of greens, other pests, fertility imbalances, or moisture extremes. Thatch removal will be helpful. In bentgrass greens, manage localized dry spots to prevent anthracnose basal rot from developing.	azoxystrobin 50WDG chlorothalonil 38.5% F chlorothalonil 54% F chlorothalonil 82.5% WDG fenarimol AS trifloxystrobin 50WDG propiconazole 14.3% myclobutanil 40% WSP triadimefon 50 WSP chlorothalonil + thiophanate methyl mancozeb + thiophanate methyl thiophanate methyl 50WSB thiophanate methyl 46%F thiophanate-methyl 41%F thiophanate methyl 50WP <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details <i>note:</i> on bentgrass greens, be cautious when utilizing , propiconazole, fenarimol, triadimefon or myclobutanil at high rates in high heat conditions as unacceptable growth regulation may occur.	0.2-0.4 oz 4.3-5.1 fl oz. >5.1-7.9 3-3.6 fl oz >3.6-5.5 2.7-3.2 oz >3.2-5 oz 1.75-3.5 fl oz 0.15-0.25 oz 1-2 fl oz 0.6 1.0 oz 2-8 oz 3 oz 1-2 oz 1-2 fl oz 2-8 fl oz 2-8 oz	14-28 7-14 pre-disease 14 pre-disease 7-14 pre-disease 14 pre-disease 7-14 pre-disease 14 pre-disease 30 14-21 14-28 14-21 30 7-14 5-14 10-14 10-14 7-14 7-14

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Brown Patch, Rhizoctonia Blight <i>(Rhizoctonia solani)</i> bluegrass creeping bentgrass fescues ryegrass	Grass is killed in circular to irregular areas that may expand to several feet in diameter. In close-cut cool season grasses, a darkened “smoke ring” border may be apparent. Brown patch in cool season grasses occurs during humid weather at >75°F. High N, thatch buildup, and excessive moisture favor disease.	Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch.	azoxystrobin 50% WG chloroneb 65WP chlorothalonil 54.0% F chlorothalonil 38.5% F chlorothalonil 82.5% WG fenarimol 11.6% AS fludioxinil 50% WP flutolanil 50% WP flutolanil 70% WP trifloxystrobin 50% WDG iprodione 50% WP iprodione 23.3% F mancozeb 37% F mancozeb 80% WP mancozeb 75% DF maneb (37%)+ zinc F myclobutanil 40% PCNB 75% WP PCNB 10% G PCNB 15% G PCNB 40F propiconazole 14.3% thiophanate methyl 50WSB thiophanate methyl 46% F thiophanate methyl 50% WP thiophanate methyl 41% F thiram 75% WDG triadimefon 50% WSP vinclozolin 50 WG or DF mancozeb (15%)+ copper hydroxide(46%) <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details <i>note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	0.2-0.4 5 oz 2-3.6 fl oz 4-5.5 fl oz 2.9-5.1 fl oz 5.8-7.9 fl oz 1.8-3.2 oz 3.6-5 oz 1.5 fl oz 0.25 oz 2-3 oz 1.5-3 oz 0.1-0.25 oz 1.5-2 oz 3-4 fl oz 6.4 fl oz 4 oz 4 oz 4.8 fl oz 0.6 3-4 oz 2-2.5 lb 1.5-2 lb 4.5-6 fl oz 1-2 fl oz 2 oz 1-2 fl oz 2-4 oz 2-4 fl oz 2.5-5 oz 0.5-1.0 oz 1-2 oz 2-4 oz	14-28 21-28 7-14 pre-disease 14 post-disease 7-14 pre-disease 14 post-disease 7-14 pre-disease 14 post-disease 7-14 7 14-21 14-21 14-21 14-28 14-28 7 7 7 7-14 14 7-10 7-10 7-10 7-10 14-21 5-14 5-14 7-14 7-14 7-10 15-30 14-28 7
Bentgrass Dead Spot <i>(Ophiosphaerella agrostis)</i> Creeping bentgrass Bermudagrass	Small, copper-colored spots appear in mild weather, in open, exposed areas. Spots become gray to tan as grass is killed. Spots are circular and generally do not coalesce. Spots expand slowly up to the size of a softball. Tiny black pseudothecia fruiting bodies may be visible with a hand lens.	Encourage turf recovery with acidifying fertilizers. If spots are few, plug out and replace with healthy turf.	Fludioxinil 50% WP	0.3-0.5 oz	14 days

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Large Patch (brown patch in warm season grasses; Zoysia patch , large patch of zoysia) <i>(Rhizoctonia solani</i> AG 2, 2 LP) zoysiagrass bermudagrass St. Augustinegrass centipedegrass	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.	azoxystrobin 50WDG chloroneb 65 WP flutolanil 50WP flutolanil 70WP triadimefon 50% WSP iprodione 23.3% F iprodione 50WP myclobutanil 40WDG PCNB 75% WP PCNB 10G PCNB 15G PCNB 40F propiconazole 14.3% thiophanate methyl 41%F thiophanate methyl 50WP	0.4 5 oz 3 oz 2.2 oz 1-2 oz 4.0 fl oz 2.0 oz 1.2 oz 16 oz 7.5 lb 5 lb 16-24 fl oz 3-4 fl oz 2-4 fl oz 2-4 oz	14-28 (1, 2 or 3 application in fall) 21-28 day 30 day 30 day First application in early fall, follow in spring if necessary First application in fall, repeat in spring 14-21 day Apply in fall before dormancy 28 day 28 day 28 day 28 day One application in early fall, prior to symptoms 7 to 14 day 7 to 14 day
Rhizoctonia Leaf and Sheath Spot <i>(R. oryzae, R. zeae)</i> bermudagrass centipedegrass creeping bentgrass St. Augustinegrass tall fescue	Occurs during summer months when weather is hot and humid. In cool season grasses, symptoms can closely mimic brown patch, caused by <i>R. solani</i> . 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.	Unknown at this time	azoxystrobin 50WDG chlorothalonil 54.0% F chlorothalonil 38.5% F chlorothalonil 82.5% WG <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details Some other active ingredients may be useful for control but are not specifically labeled for this disease – thiophanate methyl and other fungicides in the benzimidazole class are ineffective.	0.4 2-3.6 fl oz 4-5.5 fl oz 2.9-5.1 fl oz 5.8-7.9 1.8-3.2 oz 3.6-5 oz	14-28 7-14 pre-disease 14 post-disease 7-14 pre-disease 14 post-disease 7-14 pre-disease 14 post-disease
Cercospora Leaf Spot (<i>Cercospora fusimaculans</i>) St. Augustinegrass	Brown to purple leaf spots in patches 2-3" in diameter. In high disease severity, entire leaves will yellow, wither and die. Warm, humid weather favors disease incidence. Confused with gray leaf spot.	N may reduce disease. Water deeply only when needed in mornings. 'Bitter-blue' selections are more resistant.	None available. Fungicides used to control other leaf spot diseases will provide suppression.		

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Curvularia Blight (<i>Curvularia</i> spp.) All turfgrasses	Usually associated with plants that are under stress from heat, excess moisture, drought, compaction, or other causes. Bentgrass greens may develop yellow patches of 2-6 inches in diameter or greater when under high heat stress. The turf may thin slightly, but usually does not die from this disease.	Alleviate stress conditions that may occur.	thiophanate methyl 41% F thiophanate methyl 50WP	4-8 fl oz 4-8 oz	7-14 7-14
Dollar Spot (<i>Sclerotinia homoeocarpa</i>) 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 60-80°F in spring and fall. Moisture from fog, dew, or irrigation initiate disease. Low soil moisture, thatch, low N and K favor disease.	Avoid N deficiency. Irrigate in morning. Avoid thatch buildup. Wipe heavy dew off in mornings.	chlorothalonil 54.0% F chlorothalonil 38.5% F chlorothalonil 82.5% WG myclobutanil 40WSP propiconazole 14.3% triadimefon 50WSP fenarimol 11.6% AS iprodione 23.3% F iprodione 50WP mancozeb 75DF mancozeb 80WP mancozeb 37% F maneb (37%)+ zinc F PCNB 75% WP PCNB 10G PCNB 15G PCNB 40F thiophanate methyl 50WSB thiophanate methyl 46% F thiophanate methyl 50WP thiophanate methyl 41% F thiram 75WDG vinclozolin 50WP or DF mancozeb (15%)+ copper hydroxide(46%) <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details <i>note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	1-2 fl oz 2-3.6 fl oz 4-5.5 fl oz 1.4-2.9 fl oz 2.9-5.1 fl oz 5.8-7.9 fl oz 0.9-1.8 oz 1.8-3.2 oz 3.6-5 oz 0.5-1.2 oz 0.5-2 fl oz 0.25-1 oz 0.75-1.5 fl oz 3-4 1.5-2 6-8 oz 6-8 oz 9.6-12.8 fl oz 9.6-12.8 fl oz 7-10 oz 5-7.5 lb 3.3-5 lb 3 fl oz 1-2 oz 1-2 fl oz 2-4 oz 2-4 fl oz 2.5-5 oz 2 oz 2-4 oz	7-10 pre-disease 7-21 pre-disease 14 post-disease 7-10 pre-disease 7-21 pre-disease 14 post-disease 7-10 pre-disease 7-21 pre-disease 14 post-disease 14-28 7-28 14-30 10-28 14-28 14-28 7-14 7-14 7-14 7-14 28 28 28 14 7-14 10-14 7-14 7-14 7-10 14-28 7-14

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Fairy Ring <i>(Agrocybe</i> sp., <i>Chlorophyllum</i> sp., <i>Lycoperdon</i> sp., <i>Marasmius</i> sp., <i>Tricholoma</i> sp., and other mushroom fungi) All grasses	Irregularly sized circular to semi-circular bands of lush green turf become apparent. Turf within circular area may decline, turn brown and thin. Toxins may be involved, but hydrophobic soil is a major problem. Mushrooms may be associated with the rings. Rings may persist for years.	Difficult to control. Plugging or aerating to allow more water and fertilizer to reach the roots may help. Some surfactants have helped water penetration.	azoxystrobin 50WDG (suppression of rings induced by <i>Lycoperdon</i> , <i>Agrocybe</i> spp., and <i>Bovista</i> sp.) flutolanil 50WP flutolanil 70WP (may be useful depending on the mushroom genus present. In SC tests, it has proved useful for <i>Lycoperdon</i> in bentgrass and bermudagrass greens.)	0.4 oz 6 oz 2.2-4.5	28 30 21-30
Fusarium Patch and Pink Snow Mold <i>(Microdochium nivale)</i> Cool season grasses are mostly affected, including bentgrass, bluegrasses, ryegrasses, and fescues	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.	azoxystrobin 50WDG chlorothalonil 54% F chlorothalonil 38.5% F chlorothalonil 82.5% WDG fenarimol 11.6% AS fludioxinil 50% WP iprodione 23.3% F iprodione 50WP mancozeb 75 DF mancozeb 80WP mancozeb 37% F maneb (37 %)+ zinc F PCNB 75% WP PCNB 10G PCNB 15G PCNB 40F propiconazole 14.3% triadimefon 50WSP thiophanate methyl 46% F thiophanate methyl 50WSB thiophanate methyl 50WP thiophanate methyl 41% F trifloxystrobin 50WG vinclozolin 50WP or DF mancozeb (15 %)+ copper hydroxide(46%) 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.	0.2-0.4 5.5 fl oz 7.9 fl oz 5 oz 8 fl oz 0.5 oz 4-8 fl oz 2-4 oz 6-8 oz 6-8 oz 9.6-12.8 oz 9.6-12.8 fl oz 8 oz 3-5 lb 2-3.3 lb 3 fl oz 2-4 oz 1-2 oz 1-2 fl oz 2 oz 2-4 oz 2-4 fl oz 0.2-0.25 2-4 oz 2-4 oz	14-28 21-28 pre-disease 21-28 pre-disease 21-28 pre-disease 1-2 applications late fall before snow 14-21 14-21 2-6 wk 14-42 14-42 14-42 4-6 wk 4-6 wk 4-6 wk 14 Single application 60-90 5-14 5-14 7-14 7-14 fall/early spring 10-21 14-42

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Gray Leaf Spot <i>(Pyricularia grisea)</i> 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 <i>Pyricularia grisea</i> . 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 recently planted or atrazine-treated St. Augustinegrass.	azoxystrobin 50WG * no more than 2 sequential sprays chlorothalonil 54% F chlorothalonil 38.5% F chlorothalonil 82.5% WDG mancozeb 80WP mancozeb 75DF mancozeb 37% F trifloxystrobin 50WDG propiconazole 14.3% thiophanate methyl 50WSB thiophanate methyl 41% F thiophanate methyl 50WP triadimefon 50WSP chlorothalonil + thiophanate methyl chlorothalonil + fenarimol mancozeb + thiophanate methyl <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details	0.2-0.4 oz 2-3.6 fl oz 4-5.5 fl oz 2.9-5.1 fl oz 5.8-7.9 fl oz 1.8-3.2 oz 3.6-5 oz 8 oz 8 oz 12.8 fl oz 0.15-0.25 oz 1-2 fl oz 4-8 oz 4-8 fl oz 4-8 oz 0.5-1 oz 2-8 oz 3-9 fl oz 3 oz	14-28 7-10 pre-disease 14 post-disease 7-10 pre-disease 14 post-disease 7-10 pre-disease 14 post-disease 14 14 14 14-21 14 10-14 7-14 7-14 14 7-14 7-14 7-10

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
<p>"Helminthosporium" Leaf Spot (<i>Bipolaris</i>, <i>Drechslera</i>, <i>Exerohilum</i> spp.)</p> <p>bahiagrass bermudagrass bluegrass creeping bentgrass ryegrass St. Augustinegrass zoysiagrasses</p>	<p>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.</p> <p>Ryegrass, bluegrasses (<i>Poa pratensis</i> and <i>P. trivialis</i>) and bermudagrass are most susceptible. Most prevalent when temperatures range from 68-95°F during mild periods of spring and fall.</p>	<p>Maintain a balanced fertility. Irrigate deeply in the mornings. Raise mower height during disease outbreaks. Reduce thatch.</p>	<p>azoxystrobin 50WDG chlorothalonil 54.0% F</p> <p>chlorothalonil 38.5% F</p> <p>chlorothalonil 82.5% WDG</p> <p>fludioxinil 50% WP iprodione 50WP iprodione 23.3% F chlorothalonil + thiophanate methyl mancozeb + thiophanate methyl mancozeb 80WP mancozeb 75DF mancozeb 37% F mancozeb (15%)+ copper hydroxide(46%) maneb (37%)+ zinc F myclobutanil 40WDG PCNB 75WP PCNB 10G PCNB 15G PCNB 40F propiconazole 14.3% trifloxystrobin 50WDG thiophanate methyl 50WP thiophanate methyl 41% F vinclozolin 50WP or DF</p> <p><i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details</p> <p><i>note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.</p>	<p>0.2-0.4 2 fl oz 2-3.6 fl oz 4-5.5 fl oz 2.9 fl oz 2.9-5.1 fl oz 5.8-7.9 fl oz 1.8 oz 1.8-3.2 oz 3.6-5 oz 0.25-0.5 oz 1.50-2 oz 3-4 fl oz 2-8 3 4 4 oz 6.4 fl oz 4-8 oz 4.8-6.4 fl oz 0.6 oz 7-10 5-7.5 lb 3.3-5 lb 10.5-15 fl oz 1-2 fl oz 0.1-0.25 oz 4-8 oz 4-8 fl oz 1-2 oz</p>	<p>14-21 7-10 pre-disease 7-21 post-disease 14 post-disease 7-10 pre-disease 7-21 post-disease 14 post-disease 7-10 pre-disease 7-21 post-disease 14 post-disease 14-21 14-28 14-28 7-14 5-14 7-14 7-14 7-14 7-14 14 21-28 21-28 21-28 single application 14 14-28 7-14 7-14 12-28</p>

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Pythium Blight <i>(Pythium spp.)</i> All grasses	Grass dies in spots or streaks. Initially, the affected grass has a dark color and a greasy appearance, particularly in spots. Spots may develop a copper color and eventually a bleached, straw color as affected tissues die and dry. After prolonged moist or foggy periods, the cottony mycelium may be seen on the turf (note: this symptom is NOT always evident). Pythium can be spread by foot traffic or mowers passing over infected grasses. Occurs during warm, humid, foggy weather in poorly drained soils. Ryegrass, rough bluegrass, and bentgrass used for overseeding are most susceptible.	Improve aeration and drainage. Avoid frequent, shallow irrigation. Reduce mowings and minimize equipment or foot traffic across infected turf. Wash equipment that passes from infected to non-infected grass areas.	azoxystrobin 50WG * no more than 2 sequential sprays chloroneb 65WP ethazole 30WP ethazole 35WP fosetyl A1 80WDG metalaxyl 25.1% E metalaxyl 1.21% G mefenoxam 21.3% MC mefenoxam 43.6% WSP mancozeb 80WP mancozeb 75DF mancozeb 37% F mancozeb + metalaxyl mancozeb (15%)+ copper hydroxide(46%) maneb (37%)+ zinc F propamocarb 66.5L <i>To minimize the potential for resistance, alternate between classes of fungicides</i> <i>Note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	0.4 oz 4 oz 2-5 oz 2-5 oz 4-8 oz 1-2 fl oz 12.5 oz 0.5-1 fl oz 0.11-0.56 8 oz 8 oz 12.8 fl oz 6.4 oz 4-8 oz 12.8 fl oz 1.3-4	10-14 5-7 5-10 5-10 14-21 10-21 10-21 10-21 10-21 5 5 5 7-21 5 5 7-21
Pythium Root Rot <i>(Pythium spp.)</i> All grasses	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. 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.	azoxystrobin 50WDG * no more than 2 sequential sprays fosetyl A1 80WDG chloroneb 65WP ethazole 30WP Water into the root-zone. Only azoxystrobin, ethazole, fosetyl A1 formulations have Pythium Root Rot on the label. <i>To minimize the potential for resistance, alternate between classes of fungicides.</i>	0.4 4-8 oz 4 2-5	10-14 14-21 5-7 7-14

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Rust <i>(Puccinia and Uromyces spp.)</i> bermudagrass ryegrass, St. Augustinegrass tall fescue zoysiagrasses	Small yellow to orange or reddish-brown pustules on the leaves. Heavily infected area appears thin and chlorotic. Ryegrass and zoysiagrasses are most susceptible. Humid weather following a drought period favors epidemics.	Plant resistant or tolerant varieties. Maintain growth by fertilizing and irrigating adequately. Mow frequently and remove clippings.	azoxystrobin 50WDG chlorothalonil 54.0% F chlorothalonil 38.5% F chlorothalonil 82.5% WDG propiconazole 14.3% trifloxystrobin 50WDG thiophanate methyl 41% F thiophanate methyl 50WP triadimefon 50WSP mancozeb 75DF mancozeb 80WP mancozeb 75DF mancozeb 37% F maneb (37%)+ zinc F mycobutanil 40% WSP <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details	0.2-0.4 4-5.5 fl oz 5.5 fl oz 5.8-7.9 fl oz 7.9 fl oz 3.6-5 oz 5 oz 1-2 fl oz 0.1-0.25 oz 4-8 fl oz 4-8 oz 0.5-1 oz 4 oz 4 oz 3-8 oz 6.4 fl oz 1.76 fl oz 0.6 oz	14-28 14 pre-disease 14 post-disease 14 pre-disease 14 post-disease 14 pre-disease 14 post-disease 14-28 14-21 7-14 7-14 15-30 7-14 7-14 3-10 7-14 7-14 14-28

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Red Thread <i>(Laetisaria fuciformis)</i> 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.	azoxystrobin 50WDG chlorothalonil 54.0% F chlorothalonil 38.5% F chlorothalonil 82.5% WDG fenarimol AS flutolanil 50WP flutolanil 70WP iprodione 50WP iprodione 23.3% F mancozeb 80WP mancozeb 75 DF mancozeb 37% F mancozeb (15%)+ copper hydroxide(46%) maneb (37%)+ zinc F myclobutanil 40%WSP propiconazole 14.3% trifloxystrobin 50WDG thiophanate methyl 50WSB thiophanate methyl 50WP thiophanate methyl 41%F triadimefon 50WSP vinclozolin 50WP or DF <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details <i>note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	0.2-0.4 2-3.6 fl oz >3.6-5.5 fl oz 5.5 fl oz 2.9-5.1 fl oz >5.1-7.9 fl oz 7.9 fl oz 1.8-3.2 oz >3.2-5 oz 5 oz 8 fl oz 2 oz 1.5 oz 2 oz 4 fl oz 4-8 oz 4-8 oz 6.4-12.8 fl oz 4-8 oz 6.4-12.8 fl oz 0.6 2 fl oz 0.1-0.25 oz 2 oz 2-4 oz 2-4 fl oz 0.5-1 oz 1-2 oz	14-28 7-10 pre-disease 14 post-disease 14 post-disease 7-10 pre-disease 14 post-disease 14 post-disease 7-10 pre-disease 14 post-disease 14 post-disease 30 21-28 21-28 14 14 7-14 7-14 7-14 7-14 14-21 14-21 14-21 5-14 7-14 7-14 15-30 14-28
Southern Blight <i>(Sclerotium rolfsii)</i> Creeping bentgrass, bluegrasses, fescues, and ryegrasses	Yellow, circular or crescent shaped patches up to a foot in diameter, sometimes with “frog-eye” symptoms or more or less unaffected grass in the center of patches. Affected turf is a reddish-brown or bronze coloration, turning brown as it dies. Off-white or tan sclerotia of the fungus 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.	azoxystrobin 50WDG chloroneb 65WP flutolanil 50WP flutolanil 70WP triadimefon 50WSP	0.2-0.4 oz 4 oz 2 oz 1.5 oz 0.5-2 oz	14-28 5-7 21 21 14-28

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Spring Dead Spot - <i>(Ophiosphaerella korrae,</i> <i>Ophiosphaerella narmari,</i> or <i>Ophiosphaerella herpotricha)</i> 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.	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.	azoxystrobin 50WDG fenarimol 11.6% AS myclobutanil 40% WSP propiconazole 14.3% thiophanate methyl 41% F thiophanate methyl 50WP <i>note:</i> scout and map diseased spots in spring, treat with fungicides in late summer through early fall.	0.4 oz 4-6 fl oz 0.6-1.2 oz 4 fl oz 4-8 fl oz 4-8 oz	Fall, 1 or 2 applications 1 month prior to dormancy, reapply 14-28 days later Up to 3 applications beginning August Fall, 28 days 1-3 applications, 30 day interval, beginning August, if 3 applications Apply in fall before dormancy/reapply in spring when soil temperatures reach 55-60F.
Slime Mold <i>(Physarum sp., and Fuligo sp.)</i> All grasses	Bluish-gray encrustations on leaf blades. In spring and summer during heavy rain, prominent white or yellow slimy masses may develop. Slime molds are not parasites of turf.	Brush off or wash off the mold with a strong stream of water. Mow.	mancozeb 80WP mancozeb 75DF mancozeb 37% F	4-8 oz 4-8 oz 6.4-12.8 fl oz	7-14 7-14 7-14
Stripe Smut <i>(Ustilago striiformis)</i>	Tall fescue and Kentucky Bluegrass stands may become clumpy in appearance. Individual leaves appear shredded, with black linear streaks evident in the shredded leaves	General good agronomic practices for culture of the turfgrasses.	fenarimol 11.5% A.S. propiconazole 14.3% triadimefon 50WSP thiophanate methyl 50WSB thiophanate methyl 41% F thiophanate methyl 50WP myclobutanil 40WSP	15 fl oz. 1-2 fl oz. 1 oz 4-8 oz 4-8 fl oz 4-8 oz 0.6 oz	Single application in Oct. or early spring Fall or Spring Spring, Summer and Fall according to label 7-14 7-14 14-21 14

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Bermudagrass Decline <i>(Gaeumannomyces graminis var. graminis)</i> Bermudagrass Take-all Root Rot (same pathogen as above) St. Augustinegrass	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.	thiophanate methyl 41% F thiophanate methyl 50WP triadimefon 50WSP	4-8 fl oz 4-8 oz 1-2 oz	7-14 in mid-July 7-14 in mid-July 21-28 Irrigate thoroughly after fungicide application to move into the root zone
Take-all Patch <i>(Gaeumannomyces graminis var. avenae)</i> creeping bentgrass	Disease appears in spring or summer as patches of discolored turf which may or may not exhibit a "frog-eye" symptom; more common on fairways than greens. In severe cases, nonsusceptible ryegrass or bluegrasses may colonize the center of patches, giving the "frog-eye" symptom. Roots and crowns are rotted and symptoms may become more severe as heat and water stresses become greater. More common on newly constructed sand-based greens, fumigated greens, and/or soils with pH levels > 6.0.	Utilized acidifying fertilizers, such as ammonium sulfate or ammonium chloride, but at rates of N agronomically acceptable for bentgrass growth. Apply Mn at rates recommended by soil tests. Improve root health by aeration and other accepted cultural practices.	azoxystrobin 50% WG fenarimol 11.6% AS propiconazole 14.3% thiophanate methyl 41% F thiophanate methyl 50WP triadimefon 50% WSP	0.4 oz 4-8 fl oz 2-4 fl oz 4-8 fl oz 4-8 oz 1-2 oz	2 applications, 28 days apart in spring & fall. 1-2 applications 30 day apart in fall. Up to 2 applications in spring & fall. When disease symptoms appear, 7-14 day interval 21-28 Early fall & early spring.
Yellow Tuft (downy mildew) <i>(Sclerophthora macrospora)</i> 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.	fosetyl Al 80WDG mefenoxam 21.3% mefenoxam 43.6%	4-8 oz 0.5-1 fl oz 0.11-0.56 oz	14-21 10-21 10-21

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Amount of Formulation (oz/1000 sq.ft.)	Application Interval (Days)
Yellow Patch (Cool weather brown patch) <i>(Rhizoctonia cerealis)</i> bentgrass, zoysiagrass, rough bluegrass, perennial ryegrass	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	azoxystrobin fludioxinil 50% WP flutolanil 50WP flutolanil 70WP propiconazole 14.3% thiophanate methyl 41% F thiophanate methyl 50WP	0.4 0.5 oz 2 oz 1.5 oz 3-4 fl oz 4-8 fl oz 4-8 oz	28 late fall 30 days 30 days Apply preventively in fall before growth slows and in spring after growth resumes.
Localized Dry Spots/Areas/Rings (Basidiomycete fungi, primarily <i>Lycoperdon</i> spp.) - see section on Fairy Ring bentgrass and bermudagrass greens	An affected area will appear drought stressed, despite daily irrigations or rainfall, due to the soil repelling water (hydrophobic). Necrotic rings may develop. Some localized dry spot symptoms have been associated with mushroom fungi which may not necessarily be easily detected by laboratory examination.	Use wetting agents preventively. Curative management is difficult; the water-repelling(hydrophobic) soil must be broken up and wetted. Spike the dry areas frequently and irrigate the dry areas by hand several times daily. Add a wetting agent to the water.	Azoxystrobin and flutolanil have been helpful in some cases in suppression of hydrophobic soils, ring symptoms and mushroom production	see Fairy Ring section	see Fairy Ring section
Algae (various species; primarily blue-green species) All grasses Most prevalent on putting greens & other turf mowed excessively low.	Turf areas in partially shaded, damp locations become weak and begin to thin. Traffic and close-mowing enhance potential for algae development. Long-term overcast, rainy weather periods encourage algae on putting greens. These algae are commonly green or brown in color and can be sheet-like, leaf-like, or cushion-like in appearance. Due to their high water content, algae are often quite slippery. Algae growth may become so prolific that they cover turf plants and inhibit water penetration.	Improve air circulation and light exposure. Improve drainage and reduce irrigation frequency and amount. Reduce freely available nitrogen at site. On putting greens, verticut lightly, aerify, and/or topdress to disrupt and dry algal mats.	chlorothalonil 54% F chlorothalonil 38.54% F chlorothalonil 82.5% WDG mancozeb 80WP mancozeb 75DF mancozeb 37% F mancozeb (15%)+ copper hydroxide(46%) copper hydroxide 53.8% maneb (37%)+ zinc F note: chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details note: fungicides are most effective when used preventative. Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.	2-3.6 fl oz 2-3.6 fl oz 4-5.5 fl oz 2.9-5.1 fl oz 2.9-5.1 fl oz 5.8-7.9 fl oz 1.8-3.2 oz 1.8-3.2 oz 3.6-5 oz 6 oz 6 oz 9.6 fl oz 2-4 oz 16 oz in 5 gal water 9.6 fl oz	7-14 preventive 7-14 curative 14 curative 7-14 preventive 7-14 curative 14 curative 7-14 preventive 7-14 curative 14 curative 7-14 7 7-14 7-14 variable 7-14

Trade Names for Common Turf Fungicides

Common Name	Trade Name ¹
azoxystrobin	Heritage
chloroneb	Terraneb SP, Terremec SP
chlorothalonil	Daconil formulations, Manicure, Thalonil, Concorde, Echo, others
ethazole	Koban, Terrazole
fenarimol	Rubigan ² , Patchwork
fenarimol + chlorothalonil	Twosome Flowable Fungicide
fludioxinil	Medallion
flutolanil	Prostar
fosetyl Al	Aliette, Aliette Signature, Prodigy
iprodione	Chipco 26019, Chipco 26GT Flo
maneb	Manex, Maneb + zinc, Dithane M-22 Special, plus others
maneb (37%)+ zinc F	Pentathlon F
mancozeb	Fore, Dithane T&O, Tersan LSR, Manzate 200 Flowable, Protect T/O, Pentathlon DF, + others
mefenoxam	Subdue Maxx
metalaxyl	Subdue 2E, Pythium Control, Apron ⁴
metalaxyl + mancozeb	Pace
myclobutanil	Eagle, Systhane WSP
PCNB	Terraclor, Turfcide, Engage, Penstar, Revere, Defend, PCNB, plus others
propiconazole ³	Banner MAXX, Alamo
propamocarb	Banol
thiophanate methyl	Cleary 3336, Fungo, SysTec 1998, Cavalier, Scotts Systemic Fungicide
thiophanate + chloroneb	Scotts Fungicide IV
thiophanate + chlorothalonil	ConSyst, Spectro 90
thiophanate + iprodione	Scotts Fluid Fungicide
thiophanate + maneb (mancozeb)	Duosan
thiophanate + thiram	Bromosan
thiram	Spotrete 75, Spotrete-F, Thiramad, plus others
triadimefon	Bayleton, Scotts Proturf Fungicide 7, Accost 1G, Granular Turf Fungicide, Strike 25WP
triadimefon + flutolanil	ProStar Plus
triadimefon + metalaxyl	Scotts Fluid Fungicide II
triadimefon + thiram	Scotts Fluid Fungicide III
trifloxystrobin	Compass
vinclozolin	Curalan, Vorlan, Touche

¹Presence of a fungicide in this list does not constitute a recommendation. Trade names are used with the understanding that 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 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.

²Usage of this product may lead to decline of *Poa annua* in treated turf areas.

³Not for use on bermudagrass greens when temperatures exceed 90°F.

⁴This product is for seed treatment only.

Cross reference table of fungicides for major turfgrass diseases (cont.).

Fungicide	Turf Diseases											
	Pythium Blight	Pythium Root Rot	Red Thread	Rhizoctonia Leaf & Sheath Spot	Rust	Southern Blight	Spring Dead Spot	Strip Smut	Summer Patch	Take-all Patch	Yellow Patch (Cool Weather Brown Patch)	Yellow Tuft (Downy Mildew)
Aliette	✓	✓										✓
Banner Maxx			✓		✓		✓	✓	✓	✓	✓	
Banol	✓	✓										
Bayleton			✓		✓	✓		✓	✓	✓		
Chipco 26019			✓									
Cleary 3336			✓					✓				
Compass			✓		✓				✓			
Curalan			✓									
Daconil			✓	✓	✓						✓	
Eagle			✓		✓		✓	✓				
Fore	✓		✓		✓							
Heritage	✓	✓	✓			✓	✓		✓	✓	✓	
Koban/Terrazole	✓	✓										
Medallion									✓		✓	
PCNB												
Prostar			✓			✓					✓	
Rubigan			✓				✓	✓	✓	✓		
Sentinel			✓		✓	✓		✓	✓			
Spotrete												
Subdue Maxx	✓											✓
Terraneb	✓	✓				✓						

Turfgrass fungicides classified by chemical fungicide group.

Chemical Group (activity)	Common Name	Trade Name Examples
Acetanilide (Upward Mobile; Curative and Protective)	Metalaxyl Mefanoxam	Subdue, Apron (seed treatment only) Subdue Maxx
Aromatic Hydrocarbons (Contact; Protective)	Chloroneb Ethazole (Etridiazole) PCNB (Quintozene)	Terraneb, Teremec Koban, Terrazole Terraclor, PCNB, Engage, Revere, Penstar, Turfcide
Benzamide (Upward Mobile; Curative and Protective)	Flutolanil	ProStar
Benzimidazoles (Upward Mobile; Curative and Protective)	Thiophanate Methyl	Fungo 50, Fungo Flo, Cleary 3336
Benzonitrile (Contact; Protective)	Chlorothalonil	Daconil Ultrex (formerly, Daconil 2787)
Carbamates (Upward Mobile; Curative and Protective)	Propamocarb Hydrochloride	Banol
Demethylation Inhibitors (DMI) (Upward Mobile; Curative and Protective)	Cyproconazole Fenarimol Myclobutanil Propiconazole Triadimefon	Sentinel Rubigan Eagle WSP Banner Bayleton, Scotts Proturf Fungicide 7
Dicarboximides (Local-penetrant; Protective)	Iprodione Vinclozolin	Chipco 26019 Vorlan, Curalan, Touche
Dithiocarbamates (Contact; Protective)	Mancozeb Maneb Thiram	Fore, Tersan LSR, Dithane M-45, Manzate 200 FL Manex, security Maneb Spray, Dithane M-22 Special Spotrete 75, Spotrete-F, Thiramed
Organic Phosphates (Systemic; Curative and Protective)	Fosetyl-Al	Aliette, Chipco Signature, Prodigy
Strobilurines (methoxyacrylates) (Upward mobile, Curative and Protective-azoxystrobin) (local penetrant or mesostemic, curative and protective – trifloxystrobin)	Azoxystrobin Trifloxystrobin Pyraclostrobin	Heritage Compass Insignia

NEMATODE CONTROL
S. Bruce Martin
Extension Plant Pathologist

Plant parasitic nematodes are small, microscopic, thread-like animals that utilize a stylet to puncture and feed from plant cells. In turf, these nematodes are root parasites. Nematodes are important turf pests in South Carolina, 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 are generally highly restricted in 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. 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, June or July is a good time to detect high populations if 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.

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.

Plant a Different Grass. Planting another grass type may be a choice if the new grass provides acceptable quality and is adapted to the site. Sometimes nematodes are attacking a particular grass and damage is severe because it is not adapted to the site. However no variety of any turfgrass is known to have true resistance to all nematodes. Using proper turf management practices (see above) and best adapted turf species is a more practical approach than simply switching varieties.

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						
Bahiagrass	?			✓		✓
Centipedegrass	✓	✓	✓			✓
St. Augustinegrass	✓		✓	✓	✓	✓
Bermudagrass	✓	?	✓	✓	?	✓
Zoysiagrass	✓	?	✓	✓	✓	✓
Cool-season						
Creeping bentgrass	✓	?	✓			✓
Tall fescue	✓		✓			✓
Ryegrasses	✓		✓			✓
Bluegrasses	✓		✓			✓

¹Sting nematodes damage all grasses although bahiagrass is somewhat tolerant; generally found only in very sandy soils.

²Ring 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.

³Stubby-root nematodes 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 capable of causing severe damage.

⁴Lance 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 may become a predominant nematode in old greens where sting nematode has been controlled with nematicides.

⁵Root-knot nematodes are widely distributed. Found frequently in St. Augustinegrass, zoysiagrass, and bermudagrass. The effects of these nematodes on turf are not well known, but they are believed to be injurious at high population densities.

⁶Spiral nematodes are frequently found on all turfgrasses, but are not believed to cause serious damage in most circumstances.

CHEMICAL CONTROLS

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 chemical nematicides is currently the most reliable approach to reducing parasitic nematode levels in turfgrass stands. Chemical 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. They also have some insecticidal activity. All 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.

Soil Fumigation Before Planting

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

Methyl bromide is a very effective broad-spectrum biocide that has "served" the turf industry well. It is standard practice to fumigate new greens and tees and areas being replanted with methyl bromide. For treatment of small areas, methyl bromide is available in small cans (e.g., Brom-O-Gas) used under a plastic tarp seal. This is achieved not by injection but by allowing the gas to diffuse into the pores of the soil. Cans contain 1 or 1.5 lb of methyl bromide, enough to give excellent control of pests and weeds at a rate of 1 lb per 50-100 square feet. However, the commercial production of methyl bromide is scheduled to be progressively phased out by 2005. Methyl bromide will therefore likely not be available

for nematode control after the phase-out period.

When fumigants or Basamid is used the best results are usually obtained when the old sod is first stripped from the area to be treated, followed by thorough tilling of the soil at least two weeks prior to the application of the fumigant to allow adequate decomposition of old roots. Tilling loosens the soil and permits more rapid and uniform diffusion of the fumigant. At the time of application the soil should be moist (not water-saturated). Too much fumigant escapes in dry soil and too little diffuses when pores are filled with water. The temperature of the soil should be about 50 to 80°F (at a depth of 4 inches). Too much fumigant evaporates from hot soil whereas diffusion is too slow in cold soil. For maximum effectiveness, the treated area should be sealed immediately with plastic tarp for several days. It is extremely important that the fumigated area is not recontaminated by accidental introduction of nematodes in soil clinging to tools, equipment, footwear, in run-off water, or in infested soil. Pests introduced into partially sterilized soil usually reproduce rapidly because of the lack of competition from microorganisms.

Nematicides for Established Commercial Turf

Only one chemical nematicides is currently available for use on established turfgrass stands. It is an organophosphate, namely fenamiphos (Nemacur 10G or 3 EC). This material can only be used on commercial turf (including golf courses, cemeteries and industrial grounds) where the risks of exposure can be minimized. The active ingredient in the granules or emulsifiable concentrate must be carried into the soil by an adequate amount of irrigation or rain water (enough to reach the root zones and give effective control of nematodes but without product loss through leaching).

Nematicide applications should be made in autumn or spring (before nematode populations peak) during periods when soil temperatures are above 60°F according to the product label. 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. Subsurface injection in fairways is practical and should reduce the potential for off-site movement of material.

Prior to application, physical soil treatments that aid soil penetration by water (such as core cultivation, vertical mowing and mechanical thatch removal) may aid in effectiveness. Applications should be followed by adequate overhead irrigation in order to wash the active ingredient into the soil and avoid exposure of people, pets and wildlife to the chemical.

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

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

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

OVER-USE OF NEMATICIDES

No nematicide is equally effective against all nematodes. When one is used frequently, nematodes that are least affected by it will have a distinct advantage over those that are most affected by it. For instance, prolonged frequent use of a product that affects lance nematodes less than other species enables lance nematodes to become dominant in that population. We believe that this has happened with Mocap in some cases, at least in part because Mocap is not systemic (absorbed into the live root tissues) and therefore cannot reach endoparasitic nematodes that are living inside those roots.

Enhanced biodegradation is a phenomenon that can reduce the effectiveness of soil-applied pesticides where the same product has been used over a prolonged period of time. Repeated application of the same chemical to soil encourages build-up of bacteria and other microbes which can metabolize ("digest") that chemical, so they can destroy it much more quickly than was the original case. The net effect is a shorter period of control from a given treatment. Enhanced microbial degradation has been reported for over 200 soil-applied pesticides, including nematicides, which have been used too frequently on a particular site. Enhanced biodegradation of Nemacur has been documented in South Carolina recently on

several golf courses experiencing chronic problems with nematode control. Therefore, it is prudent to use all soil pesticides as little as necessary, to reduce chances of developing such soil microbial populations. It also seems wise to rotate or alternate among all products that are legal and effective for a particular problem, to avoid prolonged selection for microbes that can build up on a particular pesticide.

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

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

Nematicides for commercial turfgrass use.

Nematicide	Rate	Comments
Nemacur 10%; Turf & Ornamental Nematicide (fenamiphos 10%)	2.3 lb/1000 sq.ft. or 100 lb/A	Golf courses, cemeteries, industrial grounds; DO NOT USE on residential lawns or public recreational areas other than golf courses; not for use on turf being grown for sale or other commercial use as sod, or for commercial seed production, or for research purposes. Irrigate immediately with at least ½" of water; do not allow puddling or run-off to occur. Do not treat newly-seeded areas until plants have developed secondary root systems. Restricted Use Pesticide. See product label for further application restrictions. Not to exceed 200 lbs/acre/year.
Nemacur 3 Turf (fenamiphos 35%)	9.7 fl oz/1000 sq.ft. or 3.3 gal/A	Use on golf courses, cemeteries, and industrial grounds; not recommended for tees or greens. DO NOT USE on residential lawns or public recreational areas other than golf courses; not for use on turf being grown for sale or other commercial use as sod, or for commercial seed production, or for research purposes. Apply dosage in minimum of ½ gallon of water per 1000 sq.ft. (min. 20 GPA). Irrigate immediately after treatment with a minimum of ½ inch of water. Do not treat newly seeded areas until plants have developed secondary root systems. Do not apply more than twice per year. Restricted Use Pesticide. Do not apply to more than 10 acres per golf course per day; wait 3 days before treating any additional area. See product label for further application restrictions.

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

Nematicide Registration Sites

Nematicide	Golf Greens	Fairways	Tees	Sod Farms	Sports Fields	Cemeteries	Industrial Grounds	Home Lawns
Nemacur 3	yes	yes	yes	no	no	no	no	no
Nemacur 10G	yes	yes	yes	no	no	yes	yes	no

WEED CONTROL
Bert McCarty and Ted Whitwell
Turf and Weed Control Specialists

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

Deciding Which Herbicide to Use

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

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

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

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

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

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

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

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

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

COMMON NAME	TRADE NAME (rate)	WEEDS CONTROLLED	COMMENTS
Methyl bromide	Dowfume MC-2 Brom-o-gas Profume Terr-o-gas (1 to 2 lb/100 ft ²)	Non-selective, including bermudagrass, nutsedge, and soil pathogens & nematodes	Methyl bromide is formulated as liquid gas under pressure that forms a vapor when released. One to 1½ lb material is used per 100 sq.ft. treated soils. Use the higher rate when soils are heavy in texture, wet, or soil temperatures are below 60 F. Fumigation will not be effective if soil temperature is below 50 F. Soil should be moist but not saturated when treated. Before use, the soil should be in a condition suitable for planting including seedbed preparation by plowing soil 8 to 10 inches in depth, free of clods and undecomposed organic matter, then releasing the chemical under a gasproof (plastic) cover with the edges sealed and leaving it for 24 to 48 hours. Control will be only as deep as the soil is adequately tilled. Most other soil pests are also controlled. Grass can be planted 2 to 3 days after cover removal but do not disturb soil below 2 inches when planting. Unclassified herbicide family. Methyl bromide is a toxic material used by professional applicators only, slated to be cancelled Jan. 1, 2005. Some methyl bromide formulations are Restricted Use Pesticides. Hiring a contractor who specializes in fumigation is recommended for those unfamiliar with the process. Chloropicrin is added as 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 morningglory are not controlled by fumigants. If soil is too wet or dry, nutsedge control may be erratic.
Metam-sodium (metham)	Vapam 33% (50 to 100 gal/A)	Non-selective	A plastic or polyethylene cover is not required but increased control usually results with one. When a cover is not used a water soil-seal method should be followed. Cultivate the soil to the desired depth of fumigant penetration. Soil temperatures should be above 50F before use. Moisten the soil and use 1 to 2 pints of metham product per 100 sq.ft. in 2 to 5 gallons of water or 8 to 10 oz of Dazomet per 100 sq.ft. of prepared soil surface. The soil should then immediately be incorporated with a rotary tiller 4 to 8 inches deep and sealed with water at 15 gals. per 100 sq.ft. Light rolling will improve soil/water seal. If a cover is available, treat the soil in front of a rotary tiller. Cover the soil for 2 days. Planting may take place 2 to 3 weeks after treatment. Aeration may be required by rototilling before planting. Metham is a dithiocarbamate herbicide member. Read and follow all label directions. Metham is a restricted-use-pesticide while Dazomet is not. Control of legumes, sedges from seed, and morningglories with dazomet may be erratic.
Dazomet	Vapam HL 42% (30 to 75 gal/A) Basamid 99 Granular (255 to 450 lb/A)		
glyphosate (4 lbs ai/A)	Roundup 4S/Pro (1 gal/A)	Torpedograss, bermudagrass, 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 at 24 oz/a can be mixed with glyphosate (4 lb/gal) at 2 qts/a and applied twice for comparable control of bermudagrass (~95%) to 3 applications of glyphosate alone. For spot treatment, Glyphosate (4 lb/gal) is applied at 2 oz. per gallon of water; Reward 2EC is used at 4 teaspoons (¾ fl oz) + 1 teaspoon of nonionic surfactant per gallon of water while Finale 1SC is used at 1½ to 4 fl oz per gallon of water without additional surfactant. Do not apply to desirable plants. Glyphosate and glufosinate are Amino Acid Derviative herbicide family members while diquat is a bipyridyllum.
glufosinate (¾ to 1½ lbs ai/A)	Finale 1SC (¾ to 1½ gal/A)		
diquat (1 lb ai/A)	Reward 2EC (½ gal/A)		

PREEMERGENCE HERBICIDES¹ (Refer to Herbicide Label for Specific Species and Use Listing)

Comments. Preemergence herbicides provide 60 to 75 days residual control and require repeat applications for season-long control. Approximate timing of applications 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 soil moisture, both prior to and following preemergence herbicide application, is necessary to ensure success. Dinitroaniline herbicides (e.g., benefin, oryzalin, pendimethalin, and prodiamine) are not recommended on high traffic areas such as athletic fields, cart paths, par-three tees, and areas not well established. For these high traffic areas with goosegrass, consider using 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. Most preemergence herbicides do not require a surfactant. Fall seeded turfgrasses should not be treated with a preemergence herbicide until the following spring.

Herbicide	Preemergence Herbicide Efficacy Ratings											
	Crabgrass	Goosegrass	Annual bluegrass	Common Chickweed	Hemlock	Lawn Burweed	Speedwell spp.	Spurge	Woodsorrel (Oxalis)	FL-Pusley	Phyllanthus sp.	Purslane
atrazine (Aatrex)	F ¹	P	E	E	E	G	E	G	F	G	—	G
benefin (Balan)	G-E	F	G-E	G	G	P	P	P	—	—	—	—
benefin+oryzalin (XL)	E	G	G	G	G	--	--	F	F-G	G	—	G
benefin+trifluralin (Team)	F-G	F	G	G	G	--	--	F	F	—	—	—
bensulide (Betasan, PreSan)	G-E	P-F	F	P	P	P	P	--	—	—	—	F
bensulide + oxadiazon	E	G-E	G-E	G	--	--	--	G	—	—	—	—
dithiopyr (Dimension)	E	G-E	G-E	G	G	--	G	G	G	—	—	F
fenarimol (Rubigan)	P	P	G-E	P	P	P	P	P	P	P	—	—
isoxaben (Gallery)	P-F	P	P-F	E	G	E	G-E	G	G	F-G	—	G
metolachlor (Pennant)	F-G	P-F	G	F	--	--	--	F	P	G	P	F
napropamide (Devrinol)	G-E	G	G	E	P	E	E	P	G	P	—	G
oryzalin (Surflan)	E	G	G-E	G	G	F	P	F-G	G	G	—	G
oxadiazon + prodiamine	E	G-E	G-E	G	G	G	G	G	G	G	F-G	G
oxadiazon (Ronstar)	G-E	E	G-E	P	P	P	G	G	G	G	F-G	G
pendimethalin (Pre-M)	E	G-E	G-E	E	G	G	G-E	G	G	G	F-G	G
prodiamine (Barricade)	E	G-E	G-E	G	G	F-G	F-G	G	G	G	F-G	G
pronamide (Kerb)	P-F	P	G-E	E	F-G	P	E	P	P	—	—	G
rimsulfuron (TranXit)	P	P	G	P	P	P	P	P	P	P	P	P
simazine (Princep T&O)	P-F	P	E	E	E	G-E	E	F-G	F	G	—	G

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

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

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

Herbicides	Bahiagrass	Bentgrass¹	Bermudagrass¹	Buffalograss	Centipedegrass	St. Augustinegrass	Zoysiagrass
atrazine (Aatrex)	NR ²	NR	I (D)	I (D)	S	S	I-S
benefin (Balan)	S	NR	S	NR	S	S	S
benefin + oryzalin (XL)	S	NR	S	I (D)	S	S	S
benefin + trifluralin (Team)	S	NR	S	NR	S	S	S
bensulide (Betasan, PreSan)	S	S	S	NR	S	S	S
bensulide + oxadiazon	NR	S	S	NR	NR	NR	S
dithiopyr (Dimension)	S	S	S	S	S	S	S
ethofumesate (Prograss) ³	NR	S	S(D)	NR	NR	I	NR
isoxaben (Gallery)	S	NR	S	S	S	S	S
fenarimol (Rubigan)	NR	NR	S	NR	NR	NR	NR
metolachlor (Pennant)	S	NR	I	NR	S	S	S
napropamide (Devrinol)	S	NR	S	NR	S	S	NR
oryzalin (Surflan)	S	NR	S	S	S	S	S
oxadiazon (Ronstar)	NR	NR	S	S	NR	S	S
pendimethalin (Pre-M)	S	NR	S	S	S	S	S
prodiamine (Barricade)	S	NR	S	S	S	S	S
pronamide (Kerb)	S	NR	S	S	S	S	S
rimsulfuron (TranXit)	NR	NR	S	NR	NR	NR	NR
siduron (Tupersan)	NR	I	NR	NR	NR	NR	S
simazine (Princep)	NR	NR	I (D)	NR	S	S	S

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

²S=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.

³Ethofumesate 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.

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

Herbicides	Overseeded Ryegrass	Perennial Ryegrass	Seashore Paspalum	Tall Fescue	Red Fescue	Kentucky bluegrass	Kikuyugrass
atrazine (Aatrex)	NR	NR	NR	NR	NR	NR	NR
benefin (Balan)	NR	S	NR	S	S	S	NR
benefin + oryzalin (XL)	NR	NR	NR	S	NR	NR	NR
benefin + trifluralin (Team)	NR	S	NR	S	S	S	NR
bensulide (Betasan, PreSan)	I-S	S	NR	S	S	S	NR
bensulide + oxadiazon	NR	S	NR	S	S	S	NR
dithiopyr (Dimension)	I	S	S	S	I	S	S
ethofumesate (Prograss) ³	S(D)	S	NR	I	I	I	NR
isoxaben (Gallery)	I-S	S	NR	S	S	S	NR
fenarimol (Rubigan)	S	NR	NR	S	S	S	NR
metolachlor (Pennant)	NR	NR	NR	S	S	S	NR
napropamide (Devrinol)	NR	NR	NR	S	NR	NR	NR
oryzalin (Surflan)	NR	NR	NR	NR	NR	NR	NR
oxadiazon (Ronstar)	I	S	S	S	S	S	NR
pendimethalin (Pre-M)	NR	S	NR	S	S	S	NR
prodiamine (Barricade)	I	S	S	S	S	S	NR
pronamide (Kerb)	NR	NR	NR	NR	NR	NR	NR
rimsulfuron (TranXit)	NR	NR	NR	NR	NR	NR	NR
siduron (Tupersan)	NR	S	NR	S	S	S	NR
simazine (Princep)	NR	NR	NR	NR	NR	NR	NR

¹Check 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.

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

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

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

Trade Names	Ingredients	Bentgrass	Bermudagrass	Bermudagrass to be Overseeded (refer to label for specific timing)
Weedgrass Preventer	bensulide	✓	✓	✓
Goosegrass/Crabgrass Control	bensulide + oxadiazon	✓	✓	--
Southern Weedgrass Control	pendimethalin	--	✓	--
Dimension	dithiopyr	✓	✓	--
Devrinol	napronamide	--	✓	--
Betasan	bensulide	✓	✓	✓
Kerb	pronamide	--	✓	✓
Rubigan	fenarimol	--	✓	✓
Tupersan	siduron	✓	--	--

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

COMMON NAME (lbs ai/acre) ²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
benefin (2 to 3 lbs)	Balan 2.5G (80 to 120 lbs) 2.5 Benfin G (80 to 120 lbs) Balan 1.5EC (1a to 2 gal)	Summer annual grasses, annual bluegrass, some selected annual broadleaves.	Established Bahagrass 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, or on golf greens. Dinitroaniline herbicide.
benefin (¾ -1a lbs) + trifluralin (¾ -1a lb)	Team 2G (100 to 150 lbs) Team Pro 0.86 G (175 to 350 lbs)			Same as for benefin. For use by professional applicators only. Good for use in mixed stands containing cool and warm-season turfgrasses. Wait to reseed or overseed with ryegrass 8 weeks following the low herbicidal rate and 12 to 16 weeks after for the high herbicidal rate. Dinitroaniline herbicides.
bensulide (7½ to 12½ lbs)	Betasan 3.6G (209-348 lbs) Pre-San, Lescosan 7G (107-180 lbs) Pre-San 12.5G (60-100 lbs) Bensumec, Lescosan 4E (1.9-3.1 gal) ProTurf Weedgrass Preventer 8.5G (88-147 lbs)			Same as for benefin. Use high rate in fall for annual bluegrass control. Safe on overseeded areas and golf greens. If used on putting greens, apply 4 months before overseeding. Sulfonamide herbicide.
dithiopyr (½ lbs)	Dimension 1E (½ gal) Dimension Ultra 40WSP (0.95 lbs)	Same as for benefin, plus oxalis		Same as for benefin. May be applied to actively growing golf greens. Do not use within 3 months of seeding or sprigging. A total of 1½ lb ai/A is allowed yearly but not to exceed ½ lb ai/A per application. Provides early (1 to 3 leaf stage) postemergence crabgrass (some species) control. For preemergence <i>Poa annua</i> control, a 8 week interval is needed before ryegrass overseeding. Refer to label for additional timing and rate options. Pyridine herbicide.
metolachlor (1.8 to 3.9 lbs)	Pennant 7.8L (2 to 4 pts)	Yellow nutsedge, annual sedge, sprangletop, some annual grass (e.g., crabgrass) suppression		For use only on established bermudagrass golf course fairways, 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 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Do not use Pennant on golf greens, tees, or aprons or within 4 months of overseeding or 6 months after overseeding. Irrigate within 7 days after application. Acetanilide herbicide.

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

COMMON NAME (lbs ai/acre) ²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
napropamide (2.0 lbs)	Devrinol 50WP (4.0 lbs) Devrinol 2G (100 lbs) Devrinol 5G (40 lbs)	Same as for benefin	Established Bahia grass Bermudagrass Centipedegrass Kentucky bluegrass Red Fescue St. Augustinegrass Tall Fescue Zoysiagrass	Do not apply to immature turf less than 3 months old. A second application 8 to 10 weeks after the first is suggested. Check specific label for putting greens use. Use the reduced rates for turf maintained at lower mowing heights. Irrigate after application. Do not reseed or overseed within six months after application. Susceptibility of cool-season turfgrasses may limit its use in overseed turf. Amide herbicide.
oryzalin (1½ to 3 lbs)	Surflan 4AS (1½ to 3 qts)	Same as for benefin, plus goosegrass		Same as for benefin. Use a 1½ + 1½ lb ai/A split application approximately 60 to 75 days apart for best results. Most stable preemergence herbicide, allowing 21 days before rainfall or irrigation is needed for activation. Wait to reseed or overseed with ryegrass 90 to 120 days following application. Spring application on overseeded, cool-season grasses may prematurely thin them. Dinitroaniline herbicide.
oryzalin (1-1½ lbs) + benefin (1-1½ lbs)	XL 2G (100 to 150 lbs)			Same as for benefin. Dinitroaniline herbicide.
pendimethalin (1½ to 3 lbs)	Southern Weedgrass Control 2.68G (57 to 114 lbs) PRE-M 60DG, WP (2½-5 lbs) PRE-M 3.3 EC (4.5-7.9 pts) PRE-M/Fertilizer (check label) Pendulum 60DG, WP (2½-5 lbs) Pendulum 2G (75 to 150 lbs)	Same as for benefin, plus goosegrass, oxalis, speedwell		Same as for benefin. For use by professional applicators only. A split application of 1½ to 2.0 lb ai/A before weed seed germination followed by a 1 to 1½ lb ai/A application 75 days later provides better season-long control, especially when heavy weed pressure is expected. Use low rate on cool-season grasses. Wait to reseed or overseed with ryegrass at least 90 days following application. Check the product label for registration on bermudagrass golf greens. Use low rate on golf greens. Spring application on overseeded, cool-season grasses may prematurely thin them. Dinitroaniline herbicide.
prodiamine (¾ lbs)	Barricade 65WG (1.15 lbs) Barricade 4L (1½ pints) RegalKade (check label)	Same as for benefin plus chickweed, spurge, goosegrass		Same as for benefin. Split applications at 0.38 to 0.75 lbs ai/A 60 to 75 days apart should be used for extended control and will be required for goosegrass suppression. May be applied to established ryegrass. Do not apply more than twice yearly or to golf greens nor with 5 months of overseeding. RegalKade formulations are on dry fertilizer carriers. Dinitroaniline herbicide.

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

COMMON NAME (lbs ai/acre) ²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (2.0 lbs-sandy soil) (4.0 lbs-muck soil)	Atrazine Aatrex 4L (1-2 qts), 90DG (1.1-2.2 lbs), 80W (1.2-2.5 lbs); Purge Simazine Princep 90DF, 4L Wynstar 90DF + others	Same as for benefin plus pennywort (dollarweed), henbit, chickweed, lawn burweed (or spurweed) and some annual sedges. Perennial broadleaf weeds such as wild garlic, dock & others usually escape.	Centipedegrass St. Augustinegrass Zoysiagrass	Apply to centipedegrass, St. Augustinegrass, and zoysiagrass only. 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. 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.
oxadiazon (2 to 4 lbs)	Ronstar 2G (100 to 200 lbs) Ronstar 50W (4 to 6 lbs)	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 can be used only on dormant bermudagrass, St. Augustinegrass, or zoysiagrass turf or excessive phytotoxicity will result. Thoroughly irrigate following application to increase effectiveness. Safest preemergence herbicide on newly sprigged or high traffic areas. A combination of oxadiazon (1%) plus benefin (0.5%) on a 38% ureaformaldehyde nitrogen fertilizer is available as Regal Star. Apply at 200 lbs/a (2 + 1 lbs ai oxadiazon + benefin/a). Another combination of oxadiazon + prodiamine is available as Regalstar II 1.2G. It is on a 38% UF nitrogen fertilizer and is applied at 200 lbs/A (2 + 0.4 lbs ai oxadiazon + prodiamine/A). Oxadiazole (or Triazolinone) herbicide.
oxadiazon (1½ lb) + bensulide (6 lbs)	Goosegrass/Crabgrass Control 6.56 G (115 lbs)			Same as for oxadiazon. See label for precaution concerning use on putting greens. Apply only to dry turf and when temperatures are <80F. Irrigate-in immediately with ¼ to ½-inch water.
fenarimol (see comment)	Rubigan 1AS (see comment)	Annual bluegrass; also a fungicide	Bermudagrass	A systemic fungicide that reduces the infestation of <i>Poa annua</i> . Use 3 applications. Treatments should be spaced 10-14 days apart with the third 2 weeks prior to ryegrass overseeding and 30 days prior to <i>Poa trivialis</i> or bentgrass overseeding. Use 4 oz/1000 sq.ft. each for 3 applications; or 6 oz/1000 sq.ft. each if 2 applications are used instead of 3. A follow-up application of 2 oz/1000 sq.ft. may be necessary in early January for season-long control where weed pressure is traditionally heavy. Provides little postemergence control. See supplemental label for more information. DeMethylation Inhibitor (DMI) fungicide.
rimsulfuron (0.015 to 0.0625 lbs)	TranXit GTA 25WSP (1 to 4 oz)	Annual bluegrass		Apply 10 to 14 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.

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

COMMON NAME (lbs ai/acre)²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
pronamide (½ to 1 lb)	Kerb 50 W (1 to 2 lbs)		All warm-season grasses	Safe on all warm-season grasses. Use PRE and POST only on bermudagrass. For PRE, make application at 45 to 60 days prior to overseeding. Activated charcoal can be used at 2 to 5 lbs/1000 sq.ft. to “deactivate” pronamide when applied closer than 45 days prior to overseeding. Inconsistency between years may occur with the charcoal approach. Do not apply on or upslope to desirable overseeded turf as pronamide will move with runoff. Restricted Use Product. Amide herbicide.
isoxaben (½ to 1 lb)	Gallery 75W (1 to 1½ lbs)	Broadleaves such as chickweed, clover, henbit, bittercress, spurge, plantain, and others	Bahiagrass Buffalograss Bentgrass Bermudagrass Centipedegrass Chewings Fescue Perennial Ryegrass St. Augustinegrass Tall Fescue Zoysiagrass	Control is best for broadleaf weeds. Tank mix with another preemergence herbicide for satisfactory grass weed control. In order to activate the material, ½" water is needed following application. Not labeled for golf greens or tees. Do not reseed nor overseed within 60 days after application. Do not apply to newly seeded turf until it has been mowed 3 times. Benzamide herbicide.

¹Presence 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.

²All 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 ft²; Qt/acre x 0.7346 = oz/1000 ft²; Pint/acre x 0.3673 = oz/1000 ft²; lbs/acre x 0.02296 = lb/1000 ft².

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

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

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

Herbicides	Bentgrasses Greens	Bentgrass Fairways	Ryegrass	Tall Fescue	Fine Fescue	Kentucky bluegrass	Buffalo-grass	Seashore Paspalum
Broadleaf Weed Control								
atrazine (Aatrex)	NR	NR	NR	NR	NR	NR	I (D)	NR
bentazon (Basagran T&O)	NR-I	I	S	S	S	S	S	S-NR
bromoxynil (Buctril)	NR	NR	S	S	S	S	NR	NR
carfentrazone+2,4-D+MCP+dicamba (Speed Zone North)	NR	S	S	S	S	S	NR	NR
carfentrazone+MCPA+MCP+dicamba (Power Zone)	NR	NR	S	S	S	S	NR	NR
carfentrazone+2,4-D+MCP+dicamba (Speed Zone St.Aug.)	NR	S	S	S	S	S	S	S
chlorsulfuron (Corsair, TFC)	NR	I	NR	NR	I-S	S	NR	S
clpyralid (Lontrel)	NR	I	S	S	S	S	S	NR
2,4-D	I ¹	NR	S	S	S	S	I	S
MCP (mecoprop)	S	I	S	S	S	S	I	S
dicamba (Vanquish)	I	I	S	S	S	S	I-NR	S
2,4-D + dicamba	I	I	S	S	S	S	NR	NR
2,4-D + dichlorprop (2,4-DP)	I	I	S	S	S	S	S	S
2,4-D + MCP	I	I	S	S	S	S	NR	NR
2,4-D + triclopyr (Turflon)	NR-I	NR	S	S	I	S	NR	NR
2,4-D + MCP + dicamba	I	I	S	S	S	S	I	NR
2,4-D + MCP + 2,4-DP	I	I	S	S	S	S	NR	NR
MCPA + MCP + 2,4-DP	I	I	S	S	S	S	NR	NR
MCPA + triclopyr + clpyralid	S	S	S	S	S	S	S	NR
halosulfuron (Manage)	NR	I	S	S	S	S	NR	S
imazaquin (Image)	NR	NR	NR	NR	NR	NR	S-NR	NR
metsulfuron (Manor)	NR	NR	NR	NR	I	I	S	NR
quinclorac (Drive)	NR	S	S	S	NR	S	S	NR
simazine (Princep T&O)	NR	NR	NR	NR	NR	NR	S	NR
triclopyr (Turflon)	NR	NR	S	S	S	S	NR	NR
triclopyr + clpyralid (Confront)	NR	I	S	S	I	S	S	NR

Established Turfgrass Tolerance to Postemergence Broadleaf Herbicides (Refer to Herbicide Label for Specific Turf Species Use Listing) (cont.).

Herbicides	Bahia-grass	Bermuda-grass	Carpet-grass	Centiped e-grass	St. Augustine-grass	Zoysia-grass	Kikuyu-grass	Overseeded Ryegrass/ Blends
Broadleaf Weed Control								
atrazine (Aatrex)	NR ¹	S-I(D)	I ³	S	S	I	NR	NR
bentazon (Basagran T&O)	S	S	S	S	S	S	NR	S-I
bromoxynil (Buctril)	S	S	S	S	S	S	NR	S
carfentrazone+2,4-D+MCP+dicamba (Speed Zone North)	NR	S	NR	NR	NR	S	NR	S
carfentrazone+MCPA+MCP+dicamba (Power Zone)	NR	S	NR	NR	NR	S	NR	S
carfentrazone+2,4-D+MCP+dicamba (Speed Zone St.Aug.)	S	S	NR	S	S	S	NR	S
chlorsulfuron (Corsair, TFC)	I	S	I	I	I	I	NR	NR
clpyralid (Lontrel)	S	S	S	S	S	S	NR	S
2,4-D	S	S	I	S-I	I	S	S	S-I
MCP (mecoprop)	S	S	I	I	I	S	NR	I
dicamba (Vanquish)	S	S	I	I	I	S	NR	I
2,4-D + dicamba	S	S	I	I	I	S	NR	S-I
2,4-D + dichlorprop (2,4-DP)	S	S	I	I	I	S	S	S
2,4-D + MCP	S	S	I	I	I	S	NR	S
2,4-D + triclopyr (Turflon)	NR	NR	NR	NR	NR	NR	NR	S
2,4-D + MCP + dicamba	S	S	I	I	I	S	NR	S
2,4-D + MCP + 2,4-DP	S	S	I	I	I	S	NR	S
MCPA + MCP + 2,4-DP	S	S	I	I	I	I	NR	S
MCPA + triclopyr + clpyralid	S	S	I	S	NR	S	NR	S
halosulfuron (Manage)	S	S	S	S	S	S	S	S
imazaquin (Image)	NR	S-I	I	S	S	S	NR	NR
metsulfuron (Manor)	NR	S	I	S	S-I	S	NR	NR
quinclorac (Drive)	NR	S	NR	NR	NR	S	NR	S
simazine (Princep T&O)	NR	S-I(D)	I	S-I	S-I	I	NR	NR
triclopyr (Turflon)	NR	NR	NR	NR	NR	NR	NR	S
triclopyr + clpyralid (Confront)	I	I	NR	S	NR	S	NR	S

¹S=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.

²Asulam is labeled for Tifway' (419) Bermudagrass and St. Augustinegrass.

³Carpetgrass tolerance to herbicides listed has not fully been explored.

⁴Ethofumesate is labeled for use 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.

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

Herbicides	Bentgrasses Greens	Bentgrass Fairways	Ryegrass	Tall Fescue	Fine Fescue	Kentucky bluegrass	Buffalograss	Seashore Paspalum	Kikuyugrass
Grass Weed Control									
asulam (Asulox)	NR ¹	NR	NR	NR	NR	NR	I-NR	NR	NR
clethodim (Envoy)	NR	NR	NR	NR	NR	NR	NR	NR	NR
diclofop (Illoxan)	NR	NR	NR	NR	NR	NR	S-NR	NR	NR
DSMA, MSMA, CMA	NR-I	I	S-I	I	I	I	I	NR	NR
ethofumesate (Prograss) ⁴	NR-I	I	S	S	I	S	NR	S-NR	NR
fenoxaprop (Acclaim Extra)	NR-I	I	S	S	S	S	NR	NR	NR
fluazifop (Fusilade II)	NR	NR	NR	S-I	NR	NR	NR	NR	NR
metribuzin (Sencor Turf)	NR	NR	NR	NR	NR	NR	NR	NR	NR
pronamide (Kerb)	NR	NR	NR	NR	NR	NR	NR	S-NR	NR
rimsulfuron (TranXit)	NR	NR	NR	NR	NR	NR	NR	NR	NR
sethoxydim (Vantage)	NR	NR	NR	NR	S	NR	NR	NR	NR
quinclorac (Drive)	NR	I	S	S	I	S	S	S-NR	NR

Herbicides	Bahia-grass	Bermuda-grass	Carpet-grass ³	Centipede-grass	St. Augustine-grass	Zoysia-grass	Overseeded Ryegrass/Blends
Grass Weed Control							
asulam (Asulox)	NR	S-I ²	NR	NR	S-I	I-NR	NR
clethodim (Envoy)	NR	NR	NR	S	NR	NR	NR
diclofop (Illoxan)	NR	S	NR	NR	NR	NR	NR
DSMA, MSMA, CMA	NR	S-I	NR	NR	NR	S-I	NR
ethofumesate (Prograss) ⁴	NR	D	NR	NR	NR	NR	I
fenoxaprop (Acclaim Extra)	I-NR	I-NR	NR	NR	NR	I	I
fluazifop (Fusilade II)	NR	NR	NR	NR	NR	I	NR
metribuzin (Sencor Turf)	NR	S-I	NR	NR	NR	NR	NR
pronamide (Kerb)	S	S	NR	S	S	S	NR
rimsulfuron (TranXit)	NR	S	NR	NR	NR	NR	NR
sethoxydim (Vantage)	NR	NR	NR	S	NR	NR	NR
quinclorac (Drive)	NR	S-I	NR	NR	NR	S	S

¹S=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.

²Asulam is labeled for Tifway' (419) Bermudagrass and St. Augustinegrass.

³Carpetgrass tolerance to herbicides listed has not fully been explored.

⁴Ethofumesate is labeled for use 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	Crabgrass	Goosegrass	Annual Bluegrass	Sandspur	Dallisgrass	Thin (Bull) Paspalum	Ryegrass	Smoothgrass	Bahiagrass	Carpetgrass	Tall Fescue	Bermudagrass	Quackgrass
atrazine (Aatrex)	P-F ²	P	G-E	F	P	P	G-E	F-G	F	P	F	P-F	F
asulam (Asulox)	G	F	P	F	P	P-F	—	F	P	G	P	P	—
chlorsulfuron (Corsair, TFC)	P	P	P	P	P	P	G	F	P	P	G	P	—
clethodim (Envoy)	E	G-E	G	G	—	—	G-E	—	—	—	P	G	G
diclofop (Illoxan)	P	G-E	P	P	P	P	G	P	P	P	P	P	—
DSMA, MSMA	G	F	P	G	F	F-G	P	P	F	G	P	P	—
ethofumesate (Prograss)	P	P	F-G*	P	P	P	P	P	P	—	P	P-G	—
fenoxaprop (Acclaim)	G-E	G-E	P	G	P	P	P	P	G	—	P	F-G	—
fluazifop (Fusilade II)	G-E	G	F	G	P	P	G-E	P	G	—	P	G	G
metribuzin (Sencor)	F-G	G-E	G	—	F	P	F	P	P	—	F	P	—
metsulfuron (Manor)	P	P	P	P	P	P	G	P	G	P	F	P	—
pronamide (Kerb)	P	P	G-E	P	P	P	G-E	P	P	—	G	P	F-G
rimsulfuron (TranXit)	P	P	G	P	P	P	G	P	P	P	P	P	P
sethoxydim (Vantage)	G-E	G	P	G	P-F	P	P	P	G	P	P	F-G	F-G
simazine (Princep T&O)	P-F	P	G-E	P-F	P	P	G-E	F	F	P	F	P-F	F
quinclorac (Drive)	E	P	P	—	F	P	P	P	P	P	P	P	—

¹Repeat 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.

²E = 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.

Guide to Broadleaf Weed Control with Postemergence Turfgrass Herbicides

Weed	Lifecycle	Atrazine/ Simazine	2,4-D	MCP	Dicamba	2,4-D + MCP	2,4-D + 2,4-DP	2,4-D + MCP + dicamba	Bentazon	Bromoxynil	Chlorosulfuron	Clpyralid	Imazaquin	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clpyralid	MCPA + triclopyr + clpyralid	Carfentrazone + 2,4-D + MCP + MCPA &/or dicamba	Quinclorac
Aster	P ¹	--	G	--	--	F	G	F	P	P	--	G	--	G	--	F	G	G	G	--
Bedstraw, smooth	P	--	P	P-F	G	F	F	G	--	--	G	--	--	P	F-G	G	G	G	G	--
Beggarticks	A	G	G	--	--	--	G	G	G	--	--	--	--	--	--	G	G	G	G	--
Betony, Florida	P	F-G ²	F	F	F	F	F	F-G	P	--	--	--	--	G	--	G	G	--	G	--
Bittercress, hairy	WA	--	E	F	E	E	E	E	--	--	--	--	G	E	--	--	--	--	--	--
Bindweed, field	P	--	G	G	G	E-F	G	E	P-F	P	--	--	--	--	G	G	--	G	G	E
Burclover	A	--	F-P	E	E	E-F	E	E	--	--	F	G	--	G	G	--	--	--	G	--
Buttercups	WA,B&P	F	G	F	F-G	E	E	E	P	P	G	G	G	E	--	G	E	G	G	--
Buttonweed, Virginia	P	--	F	P-F	F	F	E-F	E-F	P	P	F	F	--	G	F	F-P	G	G	G	--
Carpetweed	SA	E	G	F	E	E	E	E	--	--	--	--	--	P	--	G	--	G	G	--
Carrot, wild	A,B	—	G	F	E	G	P-F	E	--	--	G	--	--	E	G	F	G	G	G	--
Catsear	P	--	E-F	F	E	E	E	E	--	--	--	--	--	--	--	G	E	E	--	--
Chamberbitter	SA,P	E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chickweed, common	WA	E	G	G	G	E	E	E	F-G	P	G	--	G	E	--	E	E	E	G	--
Chickweed, mouse-ear	WA,P	F	G	G	G	E	E	E	P	P	G	P	G	E	P-F	E-F	E	E	G	--
Chicory	P	--	G	E	G	E	E	E	--	--	--	--	--	E	G	G	--	G	G	--
Cinquefoil, common	P	--	E-F	E-F	E-F	E-F	E-F	E-F	--	--	F	--	--	--	--	--	--	--	G	--
Clover, crimson	SA	--	G	G	G	E	E	E	--	--	G	G	--	--	--	--	E	E	G	E
Clover, hop	WA	E	G	G	G	E	E	E	--	--	G	G	--	F	--	E	E	E	G	E
Clover, white	P	E	F-G	G	G	E	E	E	--	--	G	G	G	E	F-G	E-F	E	E	G	E
Cudweed	WA	G-E	G-E	--	E	G-E	G-E	E	--	G	--	--	G	--	--	G-E	G-E	G	--	--
Daisy, English	P	--	P	F	G	G	F	E	P	P	--	F	--	--	--	--	G	G	G	F
Daisy, oxeye	P,B	—	F	F	F	F	F	E-F	--	--	--	--	F	--	--	--	--	--	--	--
Dandelion	P	E-F	G	G	G	E	E	E	-	P	G	F-	P-F	E	G	F-E	G	G	G	F-G
Dayflower, Spreading	SA	G-E	F	F	F	F-G	F-G	F-G	G	--	--	--	G	P-F	--	F-G	--	--	G	P
Deadnettle, purple	WA	G-E	G	F	G	F	--	F-G	--	--	--	--	--	--	--	--	F	--	G	G
Dichondra	P	E-F	E	F	E-F	E	E	E	--	--	--	--	--	--	--	--	E	--	--	E
Dock, broadleaf & curly	P	F	G	F-G	F	G	G	E-F	P	P	G	G	--	G-E	G	G	E	E	G	--

Guide to Broadleaf Weed Control with Postemergence Turfgrass Herbicides

Weed	Lifecycle	Atrazine/ Simazine	2,4-D	MCP	Dicamba	2,4-D + MCP	2,4-D + 2,4-DP	2,4-D + MCP + dicamba	Bentazon	Bromoxynil	Chlorosulfuron	Clpyralid	Imazaquin	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clpyralid	MCPA + triclopyr + clpyralid	Carfentrazone + 2,4-D + MCP + MCPA &/or dicamba	Quinclorac
Dogfennel	P	--	G	--	G	--	--	E	--	--	--	--	--	G	--	E	E	G	G	--
Doveweed	SA	G-E	F	F	F	F-G	F-G	F-G	--	--	--	--	--	P-F	--	F-G	--	G	--	--
Eveningprimrose, Cutleaf	WA	E	--	--	G	G	F	G	P	F	--	--	G	--	G	G	G	G	--	--
Falsedandelion, Carolina	WA,B	P	G	G	G	--	G	--	P	P	--	G	--	G-E	P	--	G		--	--
Filaree, redstem	WA	--	P-F	--	G	--	--	--	--	--	G	--	--	--	--	--	--	--	G	--
Garlic, wild	P	P	G	P		E-F	E-F	E-F	P	P	F	--	G	G-E	--	G	--	--	G	P
Geranium, Carolina	WA	E	E	E-F	E	E	E	E	--	--	F	--	G	F-G	--	--	--	G	G	--
Groundsel	WA	--	G	G	--	G	G	G	G	G	G	G	--	G	--	G	--	--	G	--
Hawkweed	P	--	G	P	G	E-F	E-F	E-F	--	--	--	--	--	--	--	--	G	G	G	--
Healall	P	--	G	P	E-F	E	E	E	P	P	--	P	--	G	P	--	E	E	G	--
Henbit	WA	E	G	F	G	F	E-F	E	P	F	G	--	G	E-F	--	E	G	G	G	--
Horseweed	WA,SA	E	F	--	E	--	--	G-E	--	--	--	G	--	--	--	E	E	--	--	F-G
Ivy, ground	P	--	G	G	F	G	F-E	E-F	--	--	--	--	--	G	G	F	G	G	G	--
Knawel	WA	--	P	F	E	E-F	E-F	E	--	G	--	--	G	--	--	G	--	G	--	--
Knotweed, prostrate	SA	--	G	F	G	G	G	F-G	--	G	G	--	--	F	--	G	G	G	G	--
Kochia	SA	--	G	--	G	G	F	G	--	G	--	--	--	G	--	G	--	G	--	--
Lambsquarters	SA	G	G	G	G	F	F	G	G	G	G	--	--	G	G	G	F	G	G	--
Lespedeza	SA	E	F-P	E	E	E-F	F	E	--	--	--	G	--	E	G	G	E	E	G	--
Mallow	P	--	G	F	G	E-F	E-F	E-F	--	F	G	--	--	--	--	G	G	G	G	--
Medic, black	A	--	P	F	G	G	E	E	--	--	--	G	G	--	G	G	E	G	G	E
Moneywort	P	--	G	--	--	G	G	G	--	--	--	--	--	--	--	G	G	--	--	--
Mugwort	P	--	F	F-P	G-E	F	F	F	--	--	--	F-	--	--	P-F	--	--	--	--	--
Mustard, wild	WA	E	G	F	G	E	E-F	E	G	G	G	--	--	G	G	G	--	G	G	--
Nettle, stinging	P	F-G	G	--	F	F	F	F	--	--	--	--	--	--	--	F	--	G	--	--
Onion, wild	P	P	G	P	F	G	F	E	P	P	F	--	G	G-E	--	--	--	--	G	--
Parsley-piert	WA	E	P	E-F	E-F	E-F	P	E-F	G	G	--	--	G	G-E	--	E	--	--	G	--
Pearlwort	WA	--	E-F	E-F	--	E-F	E-F	E-F	--	--	--	--	--	--	F	--	--	--	--	--

Guide to Broadleaf Weed Control with Postemergence Turfgrass Herbicides

Weed	Lifecycle	Atrazine/ Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D + 2,4-DP	2,4-D + MCPP + dicamba	Bentazon	Bromoxynil	Chlorsulfuron	Clpyralid	Imazaquin	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clpyralid	MCPA + triclopyr + clpyralid	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Quinclorac
Pennywort (dollarweed)	P	E	G	G	E-F	E-F	E-F	E-F	P-F	P	--	G	F-G	G	F	--	E	E	G	E
Pepperweed, Virginia	WA	E	G	E-F	G	E-F	E	E	--	G	--	--	--	--	E	E	G	G	G	--
Pigweed	SA	G	G	G	G	E-	G	E	P	G	G	--	--	E-F	F-G	--	--	--	G	--
Pineapple-weed	WA,SA	—	F	F	--	F	F	F	--	--	G	G	--	G	--	F	--	--	G	--
Plantains	P	F-P	G	G	G	E	E	E	P	P	F	G	--	G-F	F-G	F-G	E	E	G	--
Purslane, common	SA	G	G	F	G	G	G	E-F	G	--	G	--	--	G	G	--	--	G	G	--
Pusley, Florida	SA	--	G	--	G	--	F	G	--	--	--	G	--	G	--	G	--	G	G	--
Ragweed, common	SA	G	G	G	G	G	F	G	F	G	G	G	G	G	G	G	F	G	G	--
Rocket, yellow	WA,B	—	F-G	F-G	F	G	G	G	--	G	G	--	--	--	--	G	--	G	G	--
Shepherd's-purse	WA	--	G	E-F	G	E-F	E-F	E	G	G	G	F	--	G	--	--	G	G	G	--
Sida	A	--	--	--	--	--	--	F-G	G	--	--	--	--	G	--	--	--	G	--	--
Smartweed	SA	G	G	--	G	--	G	G	G	G	G	G	G	G	G	G	F-G	G	G	--
Sorrel, red	P	--	G	E	G	G	F	G	G	G	--	G	G	G	F-G	--	E	G	G	--
Speedwell, common	P	F	F	F	P	G	G	G	P	--	G	G	F	--	F-G	G	F-G	G	--	E
Speedwell, corn	WA	E	F-P	F	F-P	G	G	G	P	G	--	G	--	G-E	F-G	G	F-G	G	--	--
Speedwell, germander	P	F	P	F	P	G	G	G	P	--	--	G	--	--	F-G	G	F-G	G	--	--
Speedwell, purslane	WA	F	--	F	--	G	G	G	P	--	--	G	--	--	F-G	-G	F-G	G	--	--
Speedwell, thymeleaf	P	F	P-F	F	P	F	G	G	P	--	--	G	--	--	F-G	G	F-G	G	--	E
Spurge, prostrate	SA	E-F	F	G	G	G	F	G	P	P	--	--	--	E	F-G	E-F	E-F	G	G	G
Spurge, spotted	SA	E	F-P	G	G	G	F	G	P	P	--	--	--	E	F-G	F	E-F	G	G	G
Spurry, corn	P	--	F	--	F-G	F	F	G	--	F-G	--	--	--	--	--	F	F	--	--	--
Spurweed (lawn burweed)	WA	F-G	F	E-F	E	E-F	F	E	E	F-G	--	--	--	G-E	F-G	E	E	G	--	--
Strawberry, Indian mock	P	--	P	F	E-F	F	P	E-F	--	--	--	--	--	--	--	--	--	--	--	--
Thistles	B,P	P	G	G	G	E-F	E-F	E	G	G	F	G	G	G	G	--	G	G	G	--
Vetch, common	WA, SA	E	G	G	G	G	F	G	--	--	--	G	G	E	G	G	E	G	--	G
Violet, Johnny-jumpup	WA	--	F-P	F-P	E-F	F-P	F	F-P	P	P	--	--	P-F	--	F	--	F-G	F-G	--	--
Violet, wild	P	--	F-P	F-P	E-F	F-P	F	F-P	P	P	F	--	--	--	F	F	F-G	F-G	G	--

Guide to Broadleaf Weed Control with Postemergence Turfgrass Herbicides

Weed	Lifecycle	Atrazine/ Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D + 2,4-DP	2,4-D + MCPP + dicamba	Bentazon	Bromoxynil	Chlorsulfuron	Clpyralid	Imazaquin	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clpyralid	MCPA + triclopyr + clpyralid	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Quinclorac
Woodsorrel, creeping	P	F	P	P	G	P-F	P-F	P-F	P	P	--	--	--	F-G	F-G	F-G	F	--	G	--
Woodsorrel, yellow	P	F	P	P	G	F-P	F-P	F-P	P	P-F	--	P	--	E-F	F-G	--	E-F	--	G	--
Yarrow	P	--	F	F	E	G	G	E-F	P	P	G	--	--	E-F	F-G	G	--	G	G	--

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

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
2,4-D Amine (½ to 1 lb) See product label.	Several Brands	Many broadleaf weeds including matchweed, dandelion, pennywort, (dollarweed), wild garlic/onion, clover, chickweed, pearlwort, plantains, buttonweed. 2,4-DB alone will not adequately control leguminous weeds.	Bahiagrass Bermudagrass Kentucky bluegrass Ryegrass Tall fescue Zoysiagrass	Apply when weeds are young and actively growing. Repeat application in 10 to 14 days may be necessary for complete control. Use lower rates (0.5 lb ai/A) on `Tifgreen' and `Tifdwarf' Bermudagrass. Amine formulations should be used near ornamentals as volatile ester formulations have drift and volatility problems. Use low rate on centipedegrass, bluegrass, fescue, and carpetgrass. Not recommended on St. Augustinegrass. For hard-to-control perennial broadleaf weeds like buttonweed, 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. Phenoxo herbicides.
2,4-D + 2,4-DP (0.7 to 0.9 each) See product label.	Weedone DPC (3 to 4 pts)			
dicamba (C to ½ lbs) See product label.	Banvel 4S Vanquish 4S (¼ to 1 pts) plus others	White clover, spurge, woodsorrel, dichondra, wild onions, henbit, knotweed, lespedeza, docks, + others		Avoid drift. Often effective on weeds not controlled by 2,4-D, therefore, is used in many 2- and 3-way mixtures. Do not apply within the root zone of ornamentals as dicamba may leach and damage desirable plants. Repeat applications 10 to 14 days apart may be needed for complete control but may also result in some turf injury. Check label for use on greens; may be used on bentgrass tees & fairways. Use one-half rate on cool-season grasses. Benzoic acid herbicide.
dicamba (C lbs) + 2,4-D, MCPP, MCPA, 2,4-DP (½ to ¾ lbs) &/or clopyralid, triclopyr, carfentrazone	Several brands contain these mixtures. See product label for specific rates.	Same as for dicamba, also matchweed, pennywort and others.		Same as for dicamba. Refer to product label for rates as herbicide ratios vary between brands. Use only on actively growing, non-stressed turf. Use low rates on cool-season grasses. Check label for use on golf greens. Mecomec 4 (¾ fl oz/1000 sq.ft.) and MCPP-4 amine (¾ fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (¾ fl oz/1000 sq.ft.), Bentgrass Selective (1 fl oz/1000 sq.ft.), and Trimec Bentgrass (1 fl oz/1000 sq.ft.) are MCPP + 2,4-D + dicamba formulations for greens, yellowing may occur.
clopyralid (0.09 to 0.5 lbs)	Lontrel T&O 3L (¼ to 1 a pts)	Broadleaf weeds, especially legumes such as clovers, vetch, and medic. Also for dock, speedwell, ragweed, and plantain.		Safe on all warm- and cool-season turfgrasses. Legumes are especially susceptible. Not labeled for golf greens or tees.
clopyralid + triclopyr (0.09-0.19 + 0.28-0.56)	Confront 3L (1 to 2 pts)			Contains no 2,4-D. Use high rates only on cool-season turfgrasses. Available for bentgrass fairways. Expect short-term phytotoxicity to warm-season grasses. Use only on grass mowed >½-inch. Picolinic acid herbicides.
triclopyr alone, (½ to 1 lb)	Turflon Ester 4L (1 to 2 pts)	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. Picolinic acid herbicide.
triclopyr +2,4-D (¼ to ½ + ½ to 1 lb)	Turflon II Amine (1 to 2 qts) Chaser 3L (1 to 2 qts)			

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
MSMA/DSMA/CMA (1.0 to 2.0 lbs)	Several brands and formulations	Crabgrass, crowfootgrass, bahiagrass, nutsedge, dallisgrass, thin paspalum, alexandergrass, sandspur, annual broadleaf weeds	Bermudagrass	Repeat (2 to 4) applications at 7-10 day intervals are necessary, especially as weeds mature. Turf discoloration may occur, especially on 'Tifdwarf' and 'Tifgreen.' Use reduced rates on these cultivars. Apply when soil moisture is adequate. A nonionic surfactant is necessary but read the label for specific instructions regarding this. Multiple applications 5 to 7 days apart are required for dallisgrass and bahiagrass control. Do not use on desirable St. Augustinegrass, centipedegrass or bahiagrass. Use low rates on zoysiagrass. Of the three, CMA causes less discoloration to turfgrasses and should be the product of choice on cool-season grasses such as Ky. bluegrass, bentgrass fairways, and tall fescue. Organic arsenical herbicides.
MSMA (1.0 lbs) + metribuzin (C to ¼ lbs)	Several brands + Sencor 75DF (0.16 to 0.33 lbs)	Crabgrass, goosegrass, dallisgrass, nutsedge, thin paspalum		Do not apply to turf under stress. Do not apply to tees, greens, or closely mowed turf. Do not add surfactant with this combination. Do not apply within the root zone of shallow rooted ornamentals. Some degree of short-term phytotoxicity can be expected, especially when applied during hot temperatures.
metribuzin (¼ to ½ lb)	Sencor 75DF (a to b lb)	Goosegrass, annual broadleaf weeds		Same as for MSMA + metribuzin above. Use higher rate on dormant bermudagrass for winter annual weed control. Use low rate on actively growing bermudagrass. Triazine herbicide.
diclofop-methyl (¾ to 1 lbs)	Illoxan 3EC (1 to 1.4 qts)	Goosegrass, ryegrass		For use only on golf courses. Young goosegrass plants are easiest to control. The high rate is needed for older plants. Larger, mature goosegrass will not be adequately controlled. Do not mow 24-36 hours after applying. Control takes 2-3 weeks. May cause temporary (7 to 10 days) phytotoxicity. Treat only well established and actively growing turf. Wait 6 weeks before overseeding after the last application. Tank mixing with MSMA, 2,4-D, or metribuzin increases turf burn and may reduce weed control. Restricted Use Pesticide. Aryl-oxy phenoxy herbicide.
ethofumesate (1 to 1½ lb)	Prograss 1.5 EC (2b to 4 qt)	Annual bluegrass, chickweed		Provides annual bluegrass control in dormant bermudagrass overseeded with perennial ryegrass. The first application at 2b qts/a should be 30 to 45 days following overseeding. The second should be 21 to 28 days later. Do not apply after January 15. May cause premature dormancy if green bermudagrass is treated. Not labeled for bermudagrass, bentgrass, bluegrass, zoysiagrass, or fine fescue greens. May injure poorly rooted, shaded or wet bentgrass fairways sites. Unclassified herbicide.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
pronamide (1 to 1½ lbs)	Kerb 50W (2 to 3 lbs)	Annual bluegrass, ryegrass clumps		Use only on bermudagrass. Do not apply on or up-slope to desirable overseeded turf as these may run. Time required for control increases as weeds mature, therefore apply in late fall for optimum results. If applied in spring, 3 to 4 weeks are required for control. If used for spring transition, do not apply before May 1. Rimsulfuron generally is the quickest to show activity. Pronamide is a Restricted Use Pesticide. Amide and sulfonyleurea herbicides.
metsulfuron (0.02 lb)	Manor/Blade 60 DF (1 oz)			
rimsulfuron (0.015 to 0.0625)	TranXit 25DG (1 to 4 oz)			
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.
glyphosate (0.375 lbs)	Roundup Pro 4L (¾ 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.
glufosinate (¾ lbs)	Finale 1SC (3 qts)			
diquat (¼ to ½ lbs)	Reward 2L (1 to 2 pts)			
clethodim (0.25 lbs)	Envoy 0.94 EC (34 oz/a)			
metribuzin (0.25 to 0.5)	Sencor 75 Turf (0.33 to 0.67 lbs)			
asulam (2.0 lbs)	Asulox 3.34L (5 pts)	Crabgrass, goosegrass, sandspur, smutgrass*	Bermudagrass, St. Augustinegrass sod production	Do not apply to freshly mowed turf or turf under stress. On Bermudagrass use on 'Tifway' only. *A repeat application for smutgrass control will be needed, but may increase turf injury and the label does not suggest more than one application per season. Do not use a surfactant. Asulox is for professional applicators only and only for sod production when used on St. Augustinegrass. Carbamate herbicide.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
atrazine/simazine (1 to 2 lbs) atrazine + bentazon (C to ¾ lbs)	Several Brands. Read the label for rates Prompt 5L (1.8 to 2.4 pts)	Many broadleaf weeds including matchweed, oxalis, pennywort, Florida betony and some annual sedges.	Centipedegrass St. Augustinegrass Zoysiagrass	For hard to control weeds, make the first application in late fall and follow with another 4 to 6 weeks later. If weeds persist, follow atrazine applications with dicamba in 4 to 6 weeks. Some turf injury can be expected with this. Two applications of atrazine are allowed per year. Effectiveness will be reduced as weeds mature. Do not apply within the root zone of ornamentals. Triazine herbicides. Prompt 5L provides additional activity on hard-to-control weeds.
metsulfuron (0.01 to 0.02 lb)	Manor 60DF Balde 60DF Escort 60DF (¼ to 1 oz)	Bahiagrass, foxtails, broadleaf weeds including chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic	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 bahiagrass. Escort is labeled for 'rough' turf such as roadsides, utility lines, and railroads while Manor is for fine turf including bermudagrass, St. Augustinegrass, zoysiagrass, centipedegrass, Ky. bluegrass and fine fescue. Some bahiagrass varieties ('Common,' 'Argentine,' & 'Paraguayan') are not completely susceptible. Sulfonylurea herbicide.
dicamba (C to ¼ lbs)	Vanquish 4S (¼-½ pts)	White clover, spurge, woodsorrel		Avoid drift. Do not apply within the root zone of ornamentals. Use low rates on St. Augustinegrass. Treat when temperatures are ≤80 F to minimize turf damage. Benzoic acid herbicide.
dicamba + 2,4-D, 2,4-DP, MCPA, and/or MCPP (C + ¼ to ½ lbs)	Several brands contain these mixtures	White clover, spurge, woodsorrel, pennywort plus other broadleaf weeds.		Observe same precaution as dicamba above. Refer to product label for rates. A second application on centipedegrass 7-14 days later may be needed. Use low rates on St. Augustinegrass. A tank mix of atrazine at 1 lb ai/A + 2,4-D & dicamba at 0.2 lb ai/A each provides good control with minimum turf damage when temperatures are ≤80 F. Phenoxy herbicides.
bromoxynil (C to ½ lb)	Buctril 2L (1 to 2 pts)	Many young broadleaf weeds		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 MCPA will provide increased control but should be used only on established turf. May also be used on bermudagrass, bentgrass, & ryegrass but not centipedegrass. Restricted Use Pesticide. Nitrile herbicide.
sethoxydim (0.19 to 0.28 lbs)	Vantage 1L (1½ to 2¼ pts)	Crabgrass, goosegrass and other annual grasses	Centipedegrass Fine Fescue	Apply before weeds mature. Repeat applications are necessary to suppress bermudagrass or bahiagrass. Safe on centipedegrass seedlings after the third mowing. Vantage has oil concentrate pre-added. Cyclohexendione herbicide.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
clethodim (0.125 to 0.25 lbs)	Envoy 0.94 EC (17 to 34 fl.oz.)	Common bermudagrass, other grasses such as johnsongrass, barnyardgrass	Centipedegrass Sod Production	This is a 24 (c) Special Local Need Label. Add non-ionic surfactant at 0.25% v/v (1 qt/100 gal). Apply only to actively growing, non-stressed turf. Repeat application may be necessary to suppress bermudagrass. Some discoloration to centipedegrass wil occur at the higher rate. Cyclohexendione herbicide.
imazapic (0.063 to 0.125 lb)	Plateau 70 DG (1.43 to 2.86 oz or 1 to 2 water soluble packs)	Bahiagrass, crabgrass, Yellow and Purple nutsedges, annual sedge & <i>Kyllinga</i> species		For centipedegrass grown as sod, on golf courses, and other recreation areas. Not for use on home lawns. The highest rate may cause turf reddening. Repeat applications may be needed for tough to control perennial weeds such as bahiagrass. See label for mixing instructions of water soluble packs.
chlorsulfuron (0.05 to ¼ lb)	Corsair 75DF, TFC 75DF (1 to 5.3 oz)	Broadleaves, wild garlic, tall fescue, perennial ryegrass in bentgrass fairways	Bermudagrass Bahiagrass Bentgrass fairways Fine fescue Kentucky bluegrass	Spot treat tall fescue & perennial ryegrass when in established Kentucky bluegrass, bentgrass fairways, or fine fescue using a hand-held sprayer delivering 1 gallon of spray solution per 1,000 sq.ft. Spray only to wet the tall fescue blades. Avoid excess-application. Repeat treatment may be needed in 60 days. Slow acting. Do not use underneath desirable shrubs or trees. Not for use in sod production. Read and follow all label directions before use. Sulfonylurea herbicide.
ethofumesate (3.0 lb)	Prograss 1.5EC (2 gal)	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 0.57EC (13 to 39 oz)	Annual weedy grasses, bermudagrass suppression	Annual bluegrass Bentgrass fairways Fine fescue Kentucky bluegrass Perennial Ryegrass Tall fescue Zoysiagrass	Young, actively growing weeds are easiest to control. Apply in late spring or early summer to actively growing weedy grasses. Do not apply to moisture- or heat-stressed turf or weeds. Repeat in 2 to 3 weeks for complete control. Control is reduced if applied within 14 days after a broadleaf herbicide. For bermudagrass suppression in tall fescue or zoysiagrass, begin treatment after spring green-up of the bermudagrass at 1½ pts/A and repeat at 3-week intervals. Seedlings should be at least 4 weeks old before treatment. Do not mow for 24 hrs after application, nor tank-mix with phenoxy herbicides. Not labeled for golf greens. The addition of triclopyr ester (Turflon Ester) may increase control but should not be used on warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.
fluziafop-butyl (0.05 to 0.1 lbs)	Fusilade T&O II 2EC (3 to 6 oz)	Annual grasses, bermudagrass suppression	Tall fescue Zoysiagrass	Add nonionic surfactant at 0.25% v/v. Begin treatment on zoysiagrass at 3 to 4 fl.oz./A in early June. Repeat application in 4 weeks. On tall fescue, make first application in spring after bermudagrass has greened-up at 5 to 6 fl.oz./A and a second application in early fall. Minor, short-term turf phytotoxicity may occur, especially when applied during hot, dry weather. The addition of triclopyr ester (Turflon Ester) may increase control but should not be used on warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
quinclorac (0.75 lb)	Drive 75 DF (1 lb)	Crabgrass, signalgrass, torpedograss, barnyardgrass, foxtail, kikuyugrass, broadleaf weeds such as pennywort, speedwells, dandelion, black medic, white clover, violets	Annual bluegrass Annual ryegrass Bentgrass fairways Buffalograss Common bermuda Kentucky bluegrass Perennial ryegrass Tall fescue Zoysiagrass	At least 2 application 3 weeks apart are needed for control of perennial weeds. Good soil moisture should be present before treatment. Creeping bentgrass, hybrid bermudagrass, & fine fescue have intermediate tolerance. Do not apply to desirable bahiagrass, centipedegrass, St. Augustinegrass, or dichondra. Tank mixing with N or Fe may lessen turf discoloration. Add a crop oil concentrate (2 pts/a) or methylated seed oil (1.5 pts/a) to increase performance. Not labeled for golf greens or collars. Avoid drift onto ornamentals. Quinolinecarboxylic Acid herbicide.
mecoprop (MCPP) alone (½ to 1 lb) or plus 2,4-D and dicamba	See comment	Postemergence annual broadleaf weeds	Bentgrass	Same as for dicamba. Refer to product label for rates as herbicide ratios vary depending on brands. Use only on actively growing, non-stressed turf. Check label for use on golf greens. Mecomec 4 (¾ fl oz/1000 sq.ft.) and MCPP-4 amine (¾ fl oz/1000 sq.ft.) are MCPP formulations labeled for greens. Triplet (¾ fl oz/1000 sq.ft.), Bentgrass Selective (1 fl oz/1000 sq.ft.), and Trimec Bentgrass (1 fl oz/1000 sq.ft.) are MCPP + 2,4-D + dicamba formulations for greens. Do not apply to stressed greens. Phenoxy herbicides.
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)	<i>Poa annua</i> var. <i>reptans</i> (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 November) plus 2 or 3 times in very early spring (March to mid April) when bentgrass is actively growing. Increased <i>Poa</i> control often occurs at the lower rate if a sterol inhibitor fungicide (DMI) such as Banner Maxx at 1 oz/1000 sq.ft. or Sentinel 40DG at C to ¼ oz/1000 sq.ft., is applied 2 weeks following each paclobutrazol applications. Do not use if <i>Poa annua</i> 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 <i>Poa annua</i> to bentgrass. Repeat applications over several years will be required. Treated <i>Poa</i> will appear noticeably lighter green in color while treated bentgrass may appear 'grainy.' Apply only to actively growing bentgrass. Type II PGR.
trinexapac-ethyl (0.05 to 0.11)	Primo 1EC (6 to 14 oz/acre or 0.14 to 0.32 fl.oz./1000ft ²)	<i>Poa annua</i> var. <i>reptans</i> (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/ <i>Poa annua</i> 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.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
siduron (8 to 12 lbs)	Tupersan 50WP (16 to 24 lbs)	Postemergence bermudagrass suppression; preemergence crabgrass control		Used alone or in combination with ethofumesate (Prograss) or flurprimidol (Cutless). Control is generally best in spring (April + May + early June) and fall (late September + October + November) when the bentgrass is actively growing and the bermudagrass is not. Also provides preemergence control of crabgrass in newly seeded areas. At least ½-inch of water is needed within 3 days of application for preemergence activity. Substituted urea herbicide.
ethofumesate + flurprimidol (see remarks)	Prograss 1.5EC + Cutless 50W (see remarks)	Postemergence bermudagrass suppression;		Apply 1 st application (March-April) when bermudagrass is breaking dormancy at 1.5 (Prograss) + 0.75 (Cutless) lb ai/A; 2 nd application 6 weeks later at 0.38 + 0.19 lb ai/a followed by 3 rd and 4 th 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.
see comment	see comment	Postemergence moss suppression (<i>Bryum argenteum</i>)		Reduce surface moisture and shade as these favor moss persistence; raise the mowing height. Repeat applications every 7 to 14 days of these provide temporary but erratic moss burn-out. 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); Ultra Dawn liquid detergent at 4 fl.oz per gallon of water applied at 30 GPA; 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 0.75 lb)	Prograss 1.5EC (3 to 4 pts)	Annual bluegrass	Creeping bentgrass fairways & Ky. bluegrass fairways & roughs; Tall fescue	Treat young (1 to 5 leaf stage) weeds in fall. Use lower rate on closer mowed turf. Will not adequately control mature plants or perennial biotypes. Multiple applications spaced 3 weeks apart may be necessary. Do not use on turf less than 8 weeks old nor reseed within 6 weeks after application. Bentgrass that is shaded, poorly drained (wet), and cold often experience herbicide damage. Unclassified herbicide.

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

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

Sedge Control	Turf Tolerance (excluding greens)
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Herbicide(s)*	Annual Sedge	Purple Nutsedge	Yellow Nutsedge	Annual Kyllinga Species	Perennial Kyllinga Species	Bermuda-grass	Bentgrass	Bluegrass, Fescue, Ryegrass	Centipede-grass	St. Augustine-grass	Bahiagrass	Zoysiagrass	Kikuyurass
Preemergence Control													
Metolachlor (Pennant)	G	P	G	F-G	P	S	NR	NR	NR	NR	NR	S	NR
Oxadiazon (Ronstar 2G)	G	P	P	F	P	S	NR	S	NR	NR	NR	S	NR
Postemergence Control													
Bentazon (Basagran T&O)	G	P	G	F-G	F-G	S	S-I	S	S	S	S	S	NR
Imazaquin (Image)	G	G	F	G	G	I-S	NR	NR	I	I	NR	S	NR
Halosulfuron (Manage)	G	G-E	G-E	G	F-G	S	S	S	S	S	S	S	S
MSMA/DSMA/CMA	G	P-F	F	G	G	S-I	I	NR	NR	NR	NR	S-I	NR
Image + MSMA/DSMA	G	G	G	G	G	S-I	NR	NR	NR	NR	NR	S-I	NR

*Repeat applications are necessary for complete control from all herbicides. This interval is from 5 days for MSMA/DSMA up to 3 to 8 weeks for Manage or Image.

G=good; F=fair; NR=not registered for use on and/or damages this turf species.

S = safe at labeled rates on mature, healthy turf.

I = intermediate safety; use lower rates during stress periods.

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

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
bentazon (1 to 2 lb)	Basagran T&O 4L (2-4 pts) Lescogran 4L (2-4 pts)	Yellow nutsedge, globe sedge, annual sedge and many annual broadleaf weeds	Bahiagrass Bermudagrass Centipedegrass Fine fescue Kentucky bluegrass St. Augustinegrass Tall fescue	Apply when yellow nutsedge is actively growing under good soil moisture conditions. Thorough spray coverage is necessary. Repeat applications in 10 to 14 days will probably be necessary. Will not satisfactory control purple nutsedge. Not labeled for golf greens. A pre-packaged combination of bentazon and atrazine is available as Prompt. <u>Benzothiadiazole herbicide.</u>
halosulfuron (0.03 to 0.06 lb)	Manage 75WP (b to 1 a oz) Sempra 75WP (b to 1 a oz)	Most nutsedges and kyllinga species; groundsel, purslane		Note the low use rate. Add 0.5% nonionic surfactant (½ gal/100 gal). Nutsedges should be actively growing when treated. Spot treat with 0.9 grams Manage 75WP + a fl oz surfactant per gallon of water. Repeat application(s) 3 to 4 weeks apart will be needed for complete control. Not labeled for golf greens. Note: Sempra is for Turfgrass Sod and Seed Farms only. <u>Sulfonylurea herbicide.</u>
MSMA (2.0 lbs) 2,4-D (2.0 lbs)	Several brands	Yellow nutsedge, annual (water) sedge	Bermudagrass Zoysiagrass	Repeat application will be needed 10 to 14 days apart. Use a wetting agent. Some turf discoloration can be expected. MSMA is an organic arsenical herbicide while 2,4-D is a phenoxy herbicide.
imazaquin (cl-½ lb)	Image 1.5LC (2-2½ pts)	Purple nutsedge, kyllinga, sandspur, wild garlic, some broadleaves	Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	Add a nonionic surfactant at 0.25% (1 qt/100 gal). Do not apply to newly seeded, sodded, or sprigged areas. Do not apply during spring transition. Not labeled for use on bahiagrass, cool-season grasses, or golf greens. Repeat applications may be required as weeds mature. For wild garlic/onion control, apply at 2 pts/A during December followed with b to 1 a pt/A in early March. Add 0.25% nonionic surfactant. Treated turf may have a compacted growth habit and seedhead formation may be inhibited. Do not use on overseeded turf. Imidazolinone herbicide.
imazaquin (cl lb) + MSMA (1 to 2 lbs)	Image 1.5LC (2 pts) + Several Brands	Most sedges and kyllinga species	Bermudagrass	Same as for MSMA and imazaquin. Repeat applications may be required as weeds mature.

¹Presence 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 ft²; Qt/acre x 0.7346 = oz/1000 ft²; Pint/acre x 0.3673 = oz/1000 ft²; lbs/acre x 0.02296 = lb/1000 ft².

CONTROL OF COMMON WEEDS

Annual Blueeyed-grass (*Sisyrinchium rosulatum*)

Winter annual, member of the Iris family; appears similar to goosegrass except it is a cool-season annual; leaves flat, light green, all clustered at the base; has zigzag shaped stems; flowers pale purple to white with a rose-purple eye ring; reproduces by seed; other *Sisyrinchium* species also commonly occur. **Control:** Products containing atrazine or simazine applied twice 30 days apart. Prompt (a pre-mix of atrazine and Basagran) also works well. Sencor also provides excellent control in tolerant turfgrasses. Products containing two- or three-way broadleaf herbicide mixtures applied at least twice 7 days apart also work.

Annual Bluegrass (*Poa annua* L.)

Small tufted to clumped yellow-green winter annual. Leaf blade smooth on both surfaces, with two distinct, clear lines, one on each side of the midrib. Folded vernation. Leaf tip keeled or boat-shaped. Ligule membranous, medium long, slightly pointed. Light green to whitish spikelets that lack cottony hairs, are arranged on branches, one to two per node, in dense to open flower clusters. Fruits throughout life cycle with majority of seedheads formed during spring. Reproduces by seed. Perennial biotypes [*P. annua* var. *reptans* (Haukskins) Timm.] occur in moist, closely mowed areas such as golf course greens. Compared to annual bluegrass, the perennial biotypes generally are darker colored, more prostrate growing, produce fewer seedheads, and often form patches from short stolons. Propagates by seed plus short stolons for the perennial biotypes. Annual biotype is throughout the world, especially in excessively wet, compacted soil. Perennial biotype is from the transition zone north in the United States usually on closely mowed golf greens, tees, and fairways under year-round high maintenance. **Control Strategies:** Control options/strategies change constantly. Check with your local state turfgrass specialist for the latest recommendations. Preemergence control includes members of the dinitroaniline herbicide family and other preemergence products (e.g., benefin, bensulide, dithiopyr, fenarimol, napropamide, oryzalin, oxadiazon, pendimethalin, and prodiamine). Apply in late summer when air temperatures reach 75 F (24 C) for several consecutive days. Early postemergence control includes atrazine/simazine/metribuzin, clethodim, diquat, ethofumesate, and pronamide. Selective suppression is provided by plant growth regulators such as paclobutrazol (Trimmit), flurprimidol (Cutless), and mefluidide (Embark).

Bahiagrass (*Paspalum notatum*)

Perennial often from roadside planting of seed. **Control Strategies:** Postemergence control in bermuda & zoysiagrass with repeat MSMA/DSMA applications at 1 to 2 lbs ai/a every 5 to 7 days starting in spring. Normally, at least 3 applications are needed. In zoysiagrass, Fusilade T&O or Acclaim Extra also as repeat applications. In centipedegrass, repeat Vantage 1L applications every 14 to 21 days at 2 pts/a. Manor 60DF at 1 oz/a applied twice 3 to 4 weeks apart works best.

Bermudagrass (*Cynodon dactylon*)

Control Strategies: Preplant: Fumigate with methyl bromide (Dowfume, Brom-o-gas, Profume, Terr-o-gas), dazomet (Basamid); or metam-sodium (Vapam). If not fumigated, use 3 repeat Roundup Pro treatments every 3 weeks at 1 gal/a each. Postemergence control: In zoysiagrass or tall fescue, repeat Acclaim Extra (0.57 EC) at 1½ pts/A or Fusilade T&O (2EC) at 5 to 6 oz/a on 30 day intervals. Use only on fescue >4 weeks old, start in spring, need good soil moisture, discontinue during summer stress. In centipedegrass, Vantage 1L at 2 pts/a, repeat in 3 weeks. In St. Augustinegrass, Prograss 1.5EC at 2 gal/A + 2 qts/a of Aatrex 4L. Begin in mid-March, repeat in 30 days.

Bermudagrass Encroachment into Bentgrass Golf Greens

An increasing problem for many golf course superintendents is the encroachment of collar region bermudagrass into bentgrass greens. **Control Strategies:** Siduron (Tupersan) and ethofumesate (Prograss) suppress bermudagrass; however, varying levels of bentgrass injury normally occur. Control is generally best in spring or fall when the bentgrass is actively growing and the bermudagrass is not. Temporary (up to three months) bermudagrass suppression has been achieved with combinations of siduron with flurprimidol (Cutless), as well as ethofumesate plus flurprimidol. This suppression has been superior to that achieved by the standard practice of using siduron alone. April treatments are less injurious to bentgrass and provide a level of bermudagrass suppression similar to a September followed by an April application. Tupersan 50WP is used at 18 to 24 oz/1000 sq.ft. in spring or fall. Repeat as needed and water-in. With Prograss 1.5EC + Cutless 50W, apply 1st application in March/April at 3 oz + 0.6 oz/1000 sq.ft. Repeat in 6 weeks at 1.7 + 0.14 oz/1000 sq.ft. Repeat again in 30 days. Temporary turf discoloration (~30%) will follow treatments.

Chamberbitter, Niruri or Gripeweed (*Phyllanthus urinaria*)

Small, erect summer annual broadleaf weed, escaped from ornamental industry; leaves oblong, arranged in two rows (mimosa-like); flowers inconspicuous (not showy); fruit green, warty, without a stalk, attached directly to underside of branch; reproduces by seed. **Control Strategies:** Products containing atrazine or simazine applied twice 30 days apart. Prompt (a pre-mix of atrazine and Basagran) also works well. Products containing two- or three-way broadleaf herbicide mixtures applied at least twice 7 days apart also work in tolerant turfgrasses. Begin treatments in spring when weeds are small.

Common Lespedeza, Annual Lespedeza or Japanese-clover (*Kummerowia striata* [*Lespedeza striata*])

Wiry, prostrate, freely-branched summer annual. Leaves with three obovate to oblong, smooth leaflets. Leaflets with prominent midvein and many parallel veins that are nearly perpendicular to the midvein. Flowers late summer. Single flowers, pink to purple, in leaf axils. Found in dry soils of open woods and fields, frequently in turf and disturbed areas. Propagates by seed. **Control Strategies:** Repeat applications of two- or three-way mixtures of 2,4-D, dicamba, MCPP, or MCPA. Other suggested options include atrazine/simazine, metribuzin, triclopyr alone or combined with clopyralid or 2,4-D, atrazine plus bentazon, imazaquin, and metsulfuron.

Dallisgrass (*Paspalum dilatatum*)

Perennial from forage/hay production. **Control Strategies:** Postemergence control in bermudagrass: repeat MSMA/DSMA applications at 1 to 2 lbs ai/a every 5 to 7 days starting in spring. Must stay on schedule. Adding Sencore 75DF at 0.19 to 0.25 lb/a to MSMA or DSMA increases control but also increases turf injury. Water if turf is drought-stressed. In other grasses, spot treat or rope wick with Roundup Pro (4S) using 2 fl oz/gal water. Begin in spring, repeat in 2 to 3 weeks. Avoid desirable plants.

Dollarweed, Pennywort (*Hydrocotyle* spp.)

Specific species include: Coastal Plain Pennywort [*Hydrocotyle bonariensis* Comm. ex Lam.]; Water or Many-flower Pennywort [*Hydrocotyle umbellata* L.]; and, Whorled Pennywort [*Hydrocotyle verticillata* Thunb.]. Perennials from rhizomes, occasionally with tubers. Erect long-stalked leaves with scalloped margins. Petiole in center of leaf, "umbrella-like". Flowers in elongated spikes or rounded umbels at top of long stalk. Flowers in summer. Found in moist to wet sites or anywhere moisture is in excess. Propagates by seed, rhizomes and tubers. **Control Strategies:** Repeat applications of two- or three-way mixtures of 2,4-D, dicamba, MCPP, or MCPA. Other suggested options include atrazine/simazine, metribuzin, triclopyr alone or combined with clopyralid or 2,4-D, atrazine plus bentazon, imazaquin, metsulfuron, and quinclorac. Best results with fall or spring treatments.

Doveweed (*Murdannia nudiflora*)

Summer annual; fleshy, creeping stems rooting at nodes; leaves alternate; small, inconspicuous blue to purple flowers; reproduces by seed. **Control Strategies:** Products containing atrazine or simazine or metsulfuron (Manor) applied twice 30 days apart. Prompt (a pre-mix of atrazine and Basagran) also works well. Tank mixes of MSMA or DSMA with Sencor or multiple application of two- or three-way broadleaf herbicide mixtures also provide good control but also can cause phytotoxicity to certain turfgrass species.

Facelis or Annual Trampweed (*Facelis retusa*)

Winter annual with freely branched stems at base. Base of stems recline along ground. Stems covered with tufts of long, soft hairs. Leaves narrow in shape, lower surface covered with white tufts of long hairs and upper surface dull green. Leaf apex indented to rounded, usually with a tiny sharp point. Small white flowers are borne in multi-flowered heads. Flowers in spring. Found in lawns, pastures, sandy fields, and waste areas. Propagates by seed. **Control strategies:** Improve turf growing conditions and maintain a regular mowing schedule. Repeat applications of two- or three-way mixtures of 2,4-D, dicamba, MCPP, or MCPA. Other suggested options include atrazine/simazine, metribuzin, triclopyr alone or combined with clopyralid or 2,4-D, atrazine plus bentazon, and metsulfuron.

Florida Betony or Rattlesnake Weed, Florida Hedge-nettle (*Stachys floridana*)

Smooth or hairy, delicate, freely branched, upright perennial herb, from slender underground stems with segmented white tubers resembling a "rattlesnake's rattle." Leaves opposite, long stalked, lance-shaped, with toothed margins, usually with a nearly flat base. Stems square. Flowers white to pink with purple spots, joined together except for the tips which are 2-lipped. Flowers mainly in early spring. Thought to be moved with nursery stock and ornamental plants. Propagates primarily by tubers, secondarily by seed. **Control Strategies:** Fumigate contaminated soil. Repeat applications of two- or three-way mixtures of 2,4-D, dicamba, MCPP, or MCPA. Other suggested options include atrazine/simazine, metribuzin, triclopyr alone or combined with clopyralid or 2,4-D, and atrazine plus bentazon.

Goosegrass (*Eleusine indica*)

Summer annual grass. Thrives in wet, compacted soils. **Control Strategies:** Preemergence control: split applications 60 days apart of PRE herbicides such as Barricade, Dimension, Pendimethalin, Ronstar, or Surflan. First applications is in early spring when soil temperatures at 4-inches reach 63 F for 24 consecutive hours. POST control with Illoxan 3EC at 1 to 1.4 qts/a, Sencor 75DF (0.19 lbs/a) + MSMA (1 lb ai/a), Fusilade 2EC (4 to 6 oz/a), or Acclaim Extra (13 to 39 oz/a). Avoid treating drought- & heat-stressed turf.

Ground Ivy (*Glechoma hederacea*)

Patch forming perennial, also known as creeping charlies. A member of the mint family with square stems and a minty odor when crushed. Paired leaves ½ to 1½ inches in diameter, opposite, somewhat kidney-shaped with toothed margins along stems. Petioles (leaf stalks) are long, bluish flowers appearing in mid to late spring. Very shade tolerant. **Control Strategies:** Reduce shade source and grow shade-tolerant turfgrasses. Herbicides include three-way combinations of 2,4-D + MCPP + dicamba. Other herbicides include those containing 2,4-DP or triclopyr; dicamba alone also works well. Mid- to late-fall applications are best followed by spring.

Knotweed, Prostrate (*Polygonum aviculare* L.)

Prostrate, mat-forming, blue-green colored summer annual broadleaf weed. Leaves alternate, smooth, oblong to linear, short-petioled, joined to stem by a sheathing membrane. Inconspicuous white flowers are formed in the leaf axils. Flowers from late spring until frost. Fruit dull brown, three-sided which remain viable for years. Common on infertile and compacted soils of cultivated fields and disturbed areas. One of the first summer annuals to germinate in the spring. Propagates by seed. **Control Strategies:** Repeat applications of dicamba or two- or three-way mixtures of 2,4-D, dicamba, MCPP, or MCPA. Other suggested options include atrazine/simazine, metribuzin, triclopyr alone or combined with clopyralid or 2,4-D. Oxadiazon may provide good PRE control if applied at or before the time for crabgrass control.

Kyllinga spp.

These appear similar to nutsedges except kyllinga species do not form underground nutlets. Perennial kyllinga species form weed patches from rhizomes. Currently, *K. nemoralis* (or "White" kyllinga) is thought to be restricted in the U.S. to Hawaii. However, it probably can survive in portions of the mainland including Southern California and South Florida. **Control Strategies:** Annual kyllinga species can be controlled with Basagran, Image, Manage or repeat applications of MSMA or DSMA. Perennial species require repeat applications of Image, Image + MSMA or Manage.

Lawn Burweed or Spurweed (*Soliva pterosperma*)

Low-growing, freely branched winter annual broadleaf weed; leaves opposite, twice divided into narrow segments or lobes; flowers small and inconspicuous; fruits have sharp spines; reproduces by seed. **Control Strategies:** Preemergence or postemergence applications of simazine or atrazine in mid-fall provide excellent control. Prompt and Sencor also work well in tolerant turfgrasses. Repeat applications of two- or three-way broadleaf herbicide mixtures also provide control. Key to control is applications in fall when weeds are small.

Mat Lippia or Matchweed (*Phyla nodiflora*)

Mat-forming perennial broadleaf plant with prostrate growing, hairy stems; stems rooting at nodes; leaves opposite with large teeth towards the tip; flowers rose-purple or white, in a head at tip of a long stalk, resembling a match head; reproduces by seed and stolons; prefers sandy coastal plains. **Control Strategies:** Products containing atrazine or simazine applied twice 30 days apart. Prompt (a pre-mix of atrazine and Basagran) also works well. Products containing two- or three-way broadleaf herbicide mixtures applied at least twice 7 days apart also work in tolerant turfgrasses.

Sandbur (Sandspur) (*Cenchrus* sp.)

Summer annual. **Control Strategies:** Preemergence control in early spring with split applications 60 days apart of PRE herbicides such as Barricade, Dimension, Pendimethalin, Ronstar, or Surflan. Postemergence control in bermuda/zoysia - MSMA (1 lb ai/a). Repeat in 10 days. In centipedegrass: Vantage 1L @ 2 pts/a. Repeat in 21 days. In fescue/zoysia - repeat Acclaim Extra (0.57 EC) at 1½ pts/A or Fusilade T&O (2EC) at 5 to 6 oz/a on 30 day intervals. Use only on fescue >4 weeks old, start in spring, need good soil moisture, discontinue during summer stress.

Smutgrass (*Sporobolus indicus*)

Clumping perennial grass; leaf blades flat, very thin; seed often infected with black fungus (or smut); reproduces by seed. **Control Strategies:** Selective control has been very elusive. Summer atrazine or simazine applications provide approximately 50% control. However, expect temporary turfgrass damage with this. TFC has smutgrass listed on its label, but control is often very erratic with this product. Non-selective control is spot spraying or rope wicking glyphosate (Roundup Pro). If rope wicking, treat in two directions.

Spreading Dayflower (*Commelina diffusa*)

Escaped from the ornamental industry; summer annual; fleshy, smooth stems; flowers with three blue petals; reproduces by seed and stem fragments; prefers moist habitats. **Control Strategies:** Products containing atrazine or simazine applied twice 30 days apart. Prompt (a pre-mix of atrazine and Basagran) also works well as does metsulfuron (Manor). Tank mixes of MSMA or DSMA with Sencor or multiple application of two- or three-way broadleaf herbicide mixtures also provide good control but also can cause phytotoxicity to certain turfgrass species.

Spurges (*Chamaesyce* sp.)

Summer annuals that include spotted, prostrate, garden, and round-leaf spurges. These often act as indicator plants for high nematode containing soils. **Control Strategies:** Manor 60DF at 0.25 oz/a provides best control. Two and three-way mixes of 2,4-D, dicamba, and MCPP also work. Repeat applications of the mixes may be necessary as plants mature.

Tall Fescue Clumps (*Festuca arundinacea*)

Perennial grass. **Control Strategies:** Postemergence control in Ky. bluegrass, fine fescue, zoysiagrass, or bermudagrass - TFC 75 DF or Corsair at 4 to 5 oz/a or as a spot treatment at 2½ grams/2 gal water. In dormant bermudagrass, spot treat with Roundup Pro 4L at 2 oz/gal water, avoid desirable green plants. Repeat in 60 days.

Thin or Bull Paspalum (*Paspalum setaceum*)

Clump forming perennial grass; leaf blades flat, hairy to almost smooth with a fringe of stiff hairs along the leaf margins; common in sandy soils; reproduces by seed & clump fragments. **Control Strategies:** Repeat applications of MSMA or DSMA are required every 7 days until complete control is achieved.

Torpedograss (*Panicum repens*)

Perennial grass, normally an aquatic weed with robust, sharply pointed, creeping rhizomes; reproduces primarily by rhizomes. **Control Strategies:** Nonselective control is with at least 3 applications of glyphosate (Roundup Pro) each spaced 3 weeks apart. Other nonselective control involves fumigating with methyl bromide and replanting. Selective control (or suppression) has recently become available with quinclorac (Drive). Drive should be applied 2 or 3 times spaced three to four weeks apart. Expect some minor temporary turfgrass discoloration.

Violets (*Viola* spp.)

Cool-season annuals and perennials often from ornamental plantings with heart-shaped leaves. These prefer moist, fertile, and shady sites. **Control Strategies:** Use products containing triclopyr and clopyralid or triclopyr + 2,4-D. Multiple applications 7 days apart are often required. Partial control is with 2,4-D + 2,4-DP. Mid- to late-fall applications are best followed by mid-spring to early summer.

Virginia Buttonweed (*Diodia virginiana*)

Perennial that reproduces from fleshy roots, cut plant pieces, and seed. Physically dig if only a few plants are present. Remove all plant parts and soil. Refill with weed-free soil and sod. **Control Strategies:** Postemergence suppression is with 2-way or 3-way herbicides with 2,4-D, dicamba, + MCPP. 2,4-D is most effective, therefore, use combination products with a high concentration of it. Repeat in 4 to 5 weeks. A combination of Corsair 75DF @ 3 oz/a + 2,4-D @ 0.5 lb ai/a, Millennium Ultra 3.75L at 2.5 pts/a, or Confront 3L at 1 pt/a have worked well. Repeat in 60 days.

Wild Garlic/onion (*Allium* sp.)

Cool-season perennials. Wild garlic has hollow leaves (stems) and round cross sections while wild onion has solid leaves which are flat in cross section. Wild Onion also has offset bulblets & a fibrous coat on the central bulb. **Control Strategies:** Postemergence control with Image 1.5L at 2 pts/a in December. Repeat with 1 pt/a in early March. Add 0.25% nonionic surfactant (1 qt/100 gal water). Also, 2,4-D LV ester alone or two- or three-way combination products. Treat in November, March, and again the following November. In dormant turf, Roundup Pro 4L at 1 pt/a, repeat in 3 to 4 weeks.

Moss

Byrum argetum has a silvery appearance, is referred to as silvery thread moss, and is found frequently on greens. Moss are threadlike, branched, primitive nonvascular plant forms encompassing many species. They are not parasitic and they spread by spores disseminated by wind and water movement. Mosses are able to photosynthesize and fix nitrogen. Moss is most noticeable on close-cut areas such as tees and putting greens that are poorly drained (thus remain continuously wet) and heavily shaded. Moss can survive weather extremes in a dormant state or by living symbiotically with blue-green algae. Algae, therefore, can be a precursor to moss encroachment and should be discouraged to prevent moss colonization. Moss mats typically develop in summer following periods of rainy, overcast, warm days. **Cultural Controls:** Control involves a long-term, persistent program combining cultural and chemical control methods realizing healthy turf is the only means to cure and prevent moss occurrence. Control begins by correcting those conditions which predispose the turf to moss growth. This involves reducing surface moisture by improving air circulation and light exposure by removing adjacent underbrush and selectively removing trees. Improve surface and subsurface drainage and reduce irrigation frequency and amount. Reduce freely available nitrogen at the site. Reduce irrigation and improve growth of the turfgrass where the moss is present so the turf can form a dense area. If the area occupied by moss is large, spiking, verticutting, and topdressing will help to break-up and dry the mat. Moss turning orange-brown or golden brown in color indicates positive desiccation is occurring. Several trends in fertility and moss development have been noted. For example, calcium-rich soil may encourage certain moss species while moss tends to be discouraged in potassium adequate soils. Ammonium sulfate at 1/10 to 1/8 lbs N/1000 sq.ft. applied weekly is thought to help desiccate moss and encourage competitive turf growth. Use only when air temperature are

below 80F and adequate moisture is present. Applying ground limestone (75 to 100 lbs/1000 sq.ft.) or hydrated lime (2 to 3 lbs/1000 sq.ft. in 3 gallons of water) will help desiccate the moss and raise the soil pH level which favors competitive turf growth. Diluted bleach and dishwashing detergent, chloride, ferrous sulfate at 4 to 7 oz/1000 sq.ft., granular iron sulfate at up to 3 lbs/1000 sq.ft., or ferrous ammonium sulfate at 10 oz/1000 sq.ft. also may help reduce moss growth. However, these should not be used on greens during hot temperatures, as they may cause varying levels of turf discoloration. Increase the mowing height as low mowing aggravates the problem. Spike or rake the dehydrated moss layer to remove any remaining impervious layer. **Chemical Controls:** Chemical control is erratic and often unsuccessful, especially if agronomic practices are not corrected which favor moss growth and development. Products containing potassium salts of fatty acids (e.g., DeMoss) applied weekly at 2 to 3 oz/1000 sq.ft. or formaldehyde may be used to control moss in turfgrasses. They control moss through a contact mode-of-action but should be carefully used and all label information followed closely. Chlorothalonil may be used but only during summer. Chlorothalonil at 16 lbs ai/a (4 oz/1000 sq.ft. for Daconil Weather Stik) applied every 7 days for 3 consecutive weeks in 5 gal water per 1000 sq.ft. Air temperatures should be above 80F (preferably, >85 F) at the time of application for success. Being nonvascular plants, high gallonage is needed for complete coverage.

Plant Growth Regulators for Fine Turf Bert McCarty and Ted Whitwell

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 fluzifop.

Type II inhibitors are generally root absorbed and suppress growth through interference of gibberellic acid bio-synthesis, a hormone responsible for cell elongation. Type II PGRs are slower in growth suppression response, but their duration is usually from 4 to 7 weeks, again, depending on application rate. Type II PGRs have little effect on seedhead development and result in miniature plants. Paclobutrazol and flurprimidol are root absorbed Type II PGRs while trinexapac-ethyl is a foliar absorbed Type II PGR and is systemically translocated to the site of activity. Fenarimol is a type II fungicide that also suppresses annual bluegrass on putting greens. Proxy 2L is a PGR with best activity on cool-season grasses. It promotes ethylene production in plants which is a regulatory hormone that restricts plant growth. Root absorbed PGRs are activated by irrigation or rainfall after application and have less likelihood of over-lap leaf burn. Foliar absorbed materials (e.g., mefluidide, MH, and trinexapac-ethyl) require uniform and complete coverage for uniform response and must be leaf absorbed before irrigation or rainfall occurs. Usually low gallonage is used for foliar absorbed materials to minimize runoff from the leaf surface while high gallonage is used for root absorbed materials.

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

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

Characteristics of Plant Growth Regulators used in Fine Turf.

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

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

Turf Use	Chemical Name (rate, lbs ai/acre)	Trade Names (rate, product)	Remarks
Bentgrass, Kentucky Bluegrass, Perennial Ryegrass, Tall and Fine Fescue Fairways, Roughs, and Commercial Areas	ethephon (3.4)	Proxy 2L (1.7 gal/acre or 5 fl oz/1000 ft ²)	Apply only to actively growing turfgrass that is not suffering heat, moisture, disease, or insect stress. Seven to 10 days are necessary for activity. Repeat applications can be made 4 weeks following the first for bentgrass and fescues and 7 weeks for Kentucky bluegrass and perennial ryegrass. Do not apply to golf greens. It is not necessary to add a spreader/sticker.
	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.
Turfgrass Clipping Management	mefluidide (0.125 to 1.0)	Embark 2S (½ to 4 pts/15-150 gal water) Embark Lite 0.2S [5 pts (St. Augustinegrass)]	Foliar absorbed. Apply to common bermudagrass (4 pts/A Embark 2S), tall fescue & Ky. bluegrass (1½ pts/A Embark 2S), and St. Augustinegrass (Embark Lite) only. Apply in spring approximately 2 weeks before seedhead appearance. Do not apply to turf within 4 growing months after seeding. Do not water-in and do not reseed within 3 days after application. Treated turf may appear less dense and temporarily discolored. Adding 1 to 2 qts of a nonionic surfactant per 100 gal of spray solution may enhance suppression; however, discoloration may also be increased. <i>Poa annua</i> seedhead control in fairways is with ½ pt/A in early January. Iron applications may lessen discoloration. Read and follow label recommendations before use. Miscellaneous family.
	flurprimidol (C to 1½)	Cutless 50 WP (¾ to 3½ lb to 200 gal water)	Root absorbed. Apply to bermudagrass or zoysiagrass golf course fairways, hard-to-mow and trimmed areas. Provides 4 to 8 week suppression. Must be uniformly applied and irrigated-in with ½ inch water. Flurprimidol does not completely control seedheads. Temporary turf discoloration may follow this treatment. St. Augustinegrass, bahiagrass, and common bermudagrass require the higher rate. Repeat applications every 4 weeks on Tifway bermudagrass with 1.0 lb/A will minimize turf injury. Do not use with S/DMI fungicides.
	trinexapac-ethyl (0.02 to 0.086)	Primo 1EC (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.
	paclobutrazol (½ to 1)	TGR Turf Enhancer 50WP (1 to 1½ lb/43 to 100 gal water)	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 and follow recommendations before use.

Turf Use	Chemical Name (rate, lbs ai/acre)	Trade Names (rate, product)	Remarks
Foliar Suppression of Overseeded Bermudagrass	mefluidide (0.125)	Embark 2S (½ pts/15-150 gal water)	Foliar absorbed. Do not apply to turf within 4 growing months after seeding, and do not reseed within 3 days after application. Treated turf may appear less dense and temporarily discolored. Adding 1 to 2 qts of a nonionic surfactant per 100 gal of spray solution may enhance suppression; however, discoloration may also be increased. <i>Poa annua</i> seedhead control in fairways is with ½ pt/A in early January. Iron applications may lessen discoloration. Read and follow label recommendations before use.
	flurprimidol (C to 1½ lb)	Cutless 50W (¾ to 3 lb/50 to 200 gal water)	Root absorbed. Apply to zoysiagrass or bermudagrass in late spring-early summer and, or late summer-early fall. Time the second application at least 3 months before expected dormancy. Do not apply to putting greens. Do not exceed 1½ lb/A per application on sandy soils. Irrigate with ½ in. water & resume mowing 3 to 5 days after application. Do not use with SI/DMI fungicides.
	paclobutrazol (¼ lb)	Turf Enhancer 50 WP (½ lb/40 to 100 gal water)	Root absorbed. Repeat applications may be made 3 weeks apart. Do not use if <i>Poa annua</i> exceeds 70%. Application should be in early January.
<i>Poa annua</i> var. <i>reptans</i> (perennial biotype) Conversion/Management in Bentgrass Golf Greens	paclobutrazol (0.375)	Turf Enhancer 50 WP (0.75 lb/acre or 0.28 oz/1000ft ²) Trimmit/Turf Enhancer 2 SC (24 oz/acre or 0.55 fl.oz./1000ft ²)	Root absorbed. Apply 30 days apart 2 to 3 times in mid-fall (September to November) plus 2 to 3 times in very early spring (March to early April) when bentgrass is actively growing. Increased <i>Poa</i> control often occurs if a sterol inhibitor fungicide (DMI) such as Banner Maxx at 1 oz/1000 sq.ft. is applied 2 weeks following each paclobutrazol applications. Do not use if <i>Poa annua</i> populations exceed 70% as severe stand thinning or discoloration may result. Note: This program is designed as a gradual transition or conversion from <i>Poa annua</i> to bentgrass. Repeat applications over several years will be required. Treated <i>Poa</i> 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.
	flurprimidol (0.125 to ½)	Cutless 50W (¼ to ½ lbs/acre)	Apply in spring or in the fall. Repeat at 3 to 4 week intervals. Final application should be 8 weeks before winter dormancy or summer stress. Delay reseeding for 2 weeks after application.
Extending the Life of Painted Lines on Sports Fields	trinexapac-ethyl	Primo 1EC (1 oz/gallon paint) Primo 25 WSB (½ oz/gallon paint)	Used to extend the life of painted lines which reduces labor costs. The life expectancy of painted lines is extended 7 to 14 days on cool-season grasses and up to 30 days on warm-season grasses. One gallon of paint should treat approximately 1000 sq.ft. of line surface area.
Chemicals for Growth & Color Promotion of Bermudagrass such as Tifdwarf & Tifgreen	Gibberellic Acid (10 grams ai/A)	RyzUp 4% active solution (10 fl oz/A or 0.23 fl oz/1000 sq.ft.)	Apply 10 grams ai/acre weekly or 25 grams ai/acre biweekly in 25 to 100 GPA to promote the growth and prevent discoloration (e.g., purpling) during periods of cold stress and light frosts on bermudagrass such as Tifdwarf or Tifgreen. Do not apply when night temperatures exceed 65F.

Read and follow all label recommendations before use. 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. $\text{Gal/acre} \times 2.938 = \text{oz}/1000 \text{ ft}^2$; $\text{Qt/acre} \times 0.7346 = \text{oz}/1000 \text{ ft}^2$; $\text{Pint/acre} \times 0.3673 = \text{oz}/1000 \text{ ft}^2$; $\text{lbs/acre} \times 0.02296 = \text{lb}/1000 \text{ ft}^2$.

Common and Trade Names of Speciality Use Herbicides and Plant Growth Regulators*

Common Name	Trade Name(s)
Ammoniated soap of fatty acids	-Quick-fire
Asulam	-Asulox 3.34L, Asulam 3.3
Atrazine	-AAtrex, Atrazine Plus, Purge II, Aatrex 90, Atrazine 4L, Bonus S, St. Augustine Weedgrass Control + others
Benefin	-Balan 2.5G, 1.5EC, Crabgrass Preventer, + others
Benefin + oryzalin	-XL 2G
Benefin + trifluralin	-Team 2G, Crabgrass Preventer 0.92%, Team Pro
Bensulide	-Betasan, Pre-San 12.5 & 7 G, Bensumec 4L, Lescosan, Weedgrass Preventer, Betamec, Squelch, + others
Bentazon	-Basagran T/O 4L, Lescogran 4L
Bentazon + atrazine	-Prompt 5L
Bromoxynil	-Buctril 2L, Brominal 4L, Bromox 2E, Moxy 2E
Cacodylic Acid	-Montar, Weed Ender
Carfentrazone + 2,4-D + MCPP + dicamba	-Speed Zone St. Augustinegrass, Power Zone, Speed Zone
Chlorsulfuron	-TFC 75DG, Corsair 75DF, Telar 75DG
Clethodim	-Envoy 0.94 EC
Clopyralid	-Lontrel T&O 3L, Transline 3L
CMA (CAMA)	-Calar, Ortho Crabgrass Killer - Formula II, Selectrol
Corn gluten	-Dynaweed, WeedzSTOP 100G
Dazomet	-Basamid
Dichlobenil	-Casoron 4G, Dyclomec 4G, Norosac 4G
2,4-D	-2,4-D Amine & Ester, Weedone LV4, Dacamine, Weedar 64, AM-40, 2,4-D LV4, Dymec, Lesco A-4D, + others
2,4-D + clopyralid + dicamba	-Millennium Ultra 3.75 lbs/gal
2,4-D + clopyralid + triclopyr	-Momentum
2,4-D + dicamba	-81 Selective Weedkiller, Four Power Plus, Triple D Lawn Weed Killer, Banvel 2,4-D
2,4-D + dichlorprop (2,4-DP)	-2D + 2DP Amine, Turf D + DP, Fluid Broadleaf Weed Control, Weedone DPC Ester & Amine + others
2,4-D + dichlorprop (2,4-DP) + dicamba	-Super Trimec, Brushmaster
2,4-D + mecoprop (MCP)	-2D Amine + 2MCP, 2 Plus 2, MCP-2,4-D, Phenomec, Ortho Weed-B-Gon Lawn Weed Killer + others
2,4-D + MCP + 2,4-DP	-Broadleaf Granular Herbicide, Dissolve, Triamine, Tri-Ester, Jet-Spray 3-Way Weed Control, Turf Weeder + others
2,4-D + MCP + dicamba + MCPA	-Trimec Southern, Three-Way Selective, Eliminate DG, 33-Plus, Dissolve, Triamine 3.9 lb/gal, TriEster, Triplet, Trex-San,
and/or 2,4-DP	Weed-B-Gon, 2 Plus 2, Bentgrass Selective Weed Killer, Trimec Bentgrass Formula, Strike 3, Broadleaf Trimec, MECamine-D, Trimec 992, Weed-B-Gon for Southern Lawns, Formula II, + others
Dicamba	-Vanquish 4 L, K-O-G Weed Control, Bentgrass Selective, Banvel 4S + others
Dicamba + MCPA + MCP	-Encore DSC, Tri-Power Dry, Tri-Power Selective, Trimec Encore
Diclofop	-Illoxan 3EC
Dithiopyr	-Dimension 1L, Dimension Ultra 40WSP
Diquat	-Reward LS, Watrol, Vegetrol, Aquatate
DSMA	-Ansar, DSMA Liquid, Methar 30, Namate, DSMA 4
DSMA + 2,4-D	-Weed Beater Plus
Ethofumesate	-Prograss 1.5L
Ethephon	-Proxy 2L, Ethephon 2

Common and Trade Names of Speciality Use Herbicides and Plant Growth Regulators*

Common Name	Trade Name(s)
Fenarimol Fenoxaprop Fluazifop Flurprimidol	-Rubigan 1AS, Patchwork 0.78G -Acclaim Extra 0.57EC -Fusilade II T&O, Ornamec -Cutless 50WP
Gibberellic Acid Glufosinate Glyphosate Glyphosate + 2,4-D	-RyzUp -Finale 1L -Roundup Pro 4L, Roundup ProDry, Gly-Flo, Glypro, AquaNeat, Razor, Rodeo 5.4L, Ortho Kleenup, Weed Wrangler, Prosecutor, Touchdown Pro, Trailblazer, Glyphomate 41 (3.8L) + others -Campaign 3.1 L
Halosulfuron Hexazinone	-Manage 75WP, Sempra 75WP -Velpar 2L
Imazapic Imazapyr Imazaquin Isoxaben Isoxaben + trifluralin	-Plateau 70DG -Arsenal 2S -Image 1.5L, 70DF -Gallery 75DF -Preen 1.9G, Snapshot TG
Maleic hydrazide Methyl chlorflurenol MCPA MCPA + clopyralid + dichlorprop MCPA + clopyralid + triclopyr MCPA + MCPP + 2,4-DP MCPA + dicamba + triclopyr MCPP MSMA MSMA + 2,4-D +MCPP + dicamba Mefluidide Metribuzin Metolachlor Metsulfuron Methyl Bromide	-Royal Slo-Gro -Maintain CF -Weedar MCPA 4 lb/gal, MCPA-4 Amine + others -Chaser Ultra -Battleship -Triamine II, Tri-Ester II -Eliminate, Three-Way Ester II -Mecomec 4, Chickweed & Clover Control, Lescopex, MCPP-4 Amine, MCPP-4K + others -Daconate 6, Dal-E-Rad, Crab-E-Rad, MSMA 6.6L, Drexar 530, Buano 6L, 120 Herbicide, Daconate Super, 912 Herbicide, MSMA Turf, Summer Crabicide, Target MSMA, + others -Trimec Plus (Quadmec) -Embark -Sencor 75DF -Pennant 7.8 lb/gal -Manor 60 DF, Blade 60DF, Escort 60 DF -Brom-O-Gas, Terr-O-Gas, MB 98, MBC
Napropamide Napropamide + oxadiazon Norflurazon	-Devrinol 50 DF, 2G, 10G, Ornamental Herbicide 5G -PrePair 6G -Predict

Common and Trade Names of Specialty Use Herbicides and Plant Growth Regulators*

Common Name	Trade Name(s)
Oryzalin	-Surflan AS 4 lb/gal
Oxadiazon	-Ronstar 2G, 50WP
Oxadiazon + benefin	-Regalstar 1.5G
Oxadiazon + bensulide	-Goosegrass/Crabgrass Control
Oxadiazon + dithiopyr	-SuperStar
Oxadiazon + prodiamine	-Regalstar II 1.2G
Oxyfluorfen	-Goal 2XL
Oxyfluorfen + oxadiazon	-OO-Herbicide 3G
Oxyfluorfen + pendimethalin	-OH2
Oxyfluorfen + oryzalin	-Rout
Paclobutrazol	-Turf Enhancer 50WP, 2SC, Trimmit 2SC, TGR
Pelargonic Acid	-Scythe
Pendimethalin	-Pre-M & Pendulum (60 DG, WP, 3.3EC, 2G), Turf Weedgrass Control, Halts, Corral 2.68G
Prodiamine	-Barricade 65WDG, Endurance 65 WDG, Factor 65 WDG, RegalKade 0.5G
Pronamide	-Kerb 50WP
Quinclorac	-Drive 75 DF
Rimsulfuron	-TranXit GTA 25DG
Sethoxydim	-Vantage 1.0 lb/gal
Siduron	-Tupersan 50WP, 4.6%
Simazine	-Princep 4 lb/gal, T&O, 80WP, Simazine, Wynstar, + others
Sulfometuron-methyl	-Oust 75DG
Sulfosulfuron	-Outrider 75DF
Triclopyr	-Turfcon Ester 4L, Garlon 3A (triclopyr amine), Garlon 4A (triclopyr ester), Pathfinder 1L (RTU)
Triclopyr + 2,4-D	-Turfcon II Amine, Chaser 3L, Chaser 2 Amine
Triclopyr + clopyralid	-Confront 3L
Triclopyr + MCPP + dicamba	-Cool Power 3.6 lb/gal, Horsepower 4.56 lb/gal, 3-Way Ester II
Trifluralin	-Treflan 5G, Trifluralin 4EC, Trilin 4EC, 5EC
Trinexapac-ethyl	-Primo 1EC, Triple Play
<i>Xanthomonas campentris</i>	-X-Po

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

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas¹
Bert McCarty

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (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 <u>while the bermudagrass is dormant</u> for the control of winter annual grass and broadleaf weeds. 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.
	glyphosate (0.38 to 0.5 lb)	Roundup Pro 4L (12 to 16 fl oz)	Roundup Pro may be applied once in January to early-March <u>while the bermudagrass is dormant</u> for the control of winter annual grass and broadleaf weeds. Glyphosate does not provide residual control.
	glyphosate (0.25 lb) + sulfometuron (0.012 lb)	Roundup Pro 4L (8 fl oz) + Oust 75DG (0.25 oz)	Roundup Pro and Oust may be tank-mixed to be applied once in December to early-March <u>while the bermudagrass is dormant</u> 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 is not delayed extensively with this treatment.
	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)	Roundup + Oust + Telar may be applied once in December through early-March <u>while the bermudagrass is dormant</u> 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 is not extensively delayed by this treatment.
	glyphosate (0.3 to 0.6 lb) + 2,4-D amine (0.48 to 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Campaign may be applied once for the control of winter annual grass and broadleaf weeds before bermudagrass greenup. It may also suppress or control broadleaf weeds tolerant of these other treatments. Refer to the label for rates for particular species. It is not necessary to add a surfactant to Campaign. Since Campaign is a formulation containing 2,4-D, use special precautions when applying in the vicinity of 2,4-D sensitive crops such as vegetables, tobacco, fruit trees, ornamentals and cotton.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Grass Weed Control in Actively Growing Bermudagrass	MSMA (2 lbs) or DSMA (3.6 lbs)	MSMA 6 L (a gal) or DSMA 3.6 L (1 gal)	May be applied during summer months every 4 to 6 weeks for suppression or control of emerged weeds. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, johnsongrass, and several broadleaf weeds.
	glyphosate (0.19 to 0.3125 lb)	Roundup Pro 4L (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. For bahiagrass growth and seedhead suppression, apply a second application at 4.0 fl. oz. product/acre 6 to 8 weeks after the initial application.
	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. Highly injurious to tall fescue. Add a nonionic surfactant at 0.25% v/v or methylated seed oil at 1.5 to 2.0 pts./acre to the spray mix. Do not apply immediately before or during bermudagrass green-up. A second treatment may be applied 6 to 10 weeks for continued growth suppression. For johnsongrass control, use 8 to 12 oz per acre when plants are 18 to 24 inches tall. Tank mixing with MSMA at 2 lbs ai/a 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.
	sulfometuron (0.023lb)	Oust 75DG (0.5 oz)	Oust may be applied after full spring green-up of bermudagrass to suppress bahiagrass growth and seedhead development and for the control of certain broadleaf weeds. 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. A nonionic surfactant at 0.25% v/v should be added to the spray mix.
	glyphosate (0.19 lb) + sulfometuron (0.012 lb) or MSMA (2 lbs ai/a) + sulfometuron	Roundup Pro 4L (6 fl oz) + Oust 75DG (0.25 oz) or MSMA 6L (a gal) + Oust (0.25 oz)	Roundup Pro + 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 Roundup Pro + 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.
	glyphosate (0.3 + 0.48lb) + 2,4-D (0.45 + 0.72 lb)	Campaign 3.1L (1 to 1½ qts)	Campaign may be applied to actively growing well established bermudagrass and bahiagrass to suppress or control emerged weeds and to allow the release of the bermudagrass. Use the low rate on bahiagrass. This treatment will control many broadleaf weeds tolerant of MSMA, DSMA, Roundup Pro, or Roundup Pro + 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.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
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.
	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.
	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.
General Broadleaf Weed Control including thistles	dicamba (C to ¼ lb)	Vanquish 4S (1 to 2 pts)	Add 1 to 2 qts nonionic surfactant per 100 gal of water. Apply March through July in 20 to 40 gal water per acre as a broadcast application or 100 gal per acre as a handgun or backpack application. Add a tracker dye and drift control agent. Avoid drift especially near sensitive crops. Do not apply within the rootzone of ornamentals. Controls many broadleaf weeds including white clover, spurge, thistles, woodsorrel. Treat small (3-in) tall weeds for best control. May be tank mixed with 2,4-D, Princep, Garlon and other herbicides to broaden weed and brush control spectrum. See label for instruction.
	triclopyr (1.5 lbs)	Garlon 3A (2 qts)	Apply to actively growing plants. Add 2 to 4 qts. nonionic surfactant per 100 gals of spray.
	clopyralid (0.28 to 0.5 lb)	Transline 3L (12 to 21 oz)	Add 1 to 2 qts of nonionic surfactant to 100 gal of solution. Apply March through early May for winter broadleaf weeds and late June to early October for summer broadleaf weeds. Apply in 20 to 40 gal water per acre as a broadcast application or 100 gal per acre as a handgun or backpack application. Add a tracker dye and drift control agent. Controls kudzu, locust, redbud, mimosa, clover, sericea lespedeza.
Kudzu	clopyralid (0.5 lb)	Transline 3L (21 oz)	Used as a broadcast or spot treatment. Add 1 pt nonionic surfactant in 50 to 100 gals water. Apply during periods of active growth from June to Sept. Will also kill locust, redbud, mimosa trees, clover, sericea lespedeza.
	triclopyr (see trade name rates)	Garlon 3A (1½ to 2 gal) Garlon 4 (1 gal/100 gal solution)	Amine formulation. Used as a spot or broadcast treatment. Add 1 to 2 pts surfactant per acre. Coverage should be to wet all leaves, stems, and root collars. Best control is with mid- to late-summer treatments (June to Sept). Ester formulation. Used as a spot treatment in 20 to 100 gal water per acre. Add 1 to 2 qts surfactant. Best control is with mid- to late-summer treatments (June to Sept). Refer to label for application guidelines.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	metsulfuron (0.045 lb)	Escort 60DF (3 to 4 oz)	Note the low use rate. Add 1 to 2 qt surfactant per 100 gal spray mix. Do not treat desirable bahiagrass. For handgun application, use 100 to 150 gal of spray mix per acre. Use 20 to 40 gal per acre for broadcast application. Thoroughly spray foliage and stems without excessive runoff.
Bahiagrass Seedhead Suppression	imazapic (0.0625 to 0.125 lb)	Plateau 2EC (¼ to ½ pt/A)	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. Treated areas may appear less dense and temporarily discolored. 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 4 lb/gal (4 to 8 fl oz/10-25 gal water)	Foliar absorbed. Apply to bahiagrass only. Add 2 qts nonionic surfactant per 100 gals spray. Note: Glyphosate is a nonselective herbicide if applications exceed these recommended rates. Make application after full greenup of bahiagrass (timing will vary across the state). Treated areas may appear less dense and temporarily discolored. Initial application of Roundup 4L or generic glyphosate (4L) at 8 oz/A followed by 4 to 6 oz/A 6 weeks later has provided good results. Read and follow label recommendations prior to use. Amino Acid Derivative family.
	glyphosate + 2,4-D	Campaign 2.5L (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 and seedhead development and for the control of certain broadleaf weeds. A second treatment may be applied about 6 to 10 weeks later for continued suppression. Often tank-mixed with Roundup or Campaign. Treated areas may appear less dense and temporarily discolored. Sulfonylurea family.
Bahiagrass and Weed Suppression in Actively Growing Fescue	MSMA (2 lbs) or DSMA (3.6 lbs)	MSMA 6 L (1/3 gal) or DSMA 3.6 L (1 gal)	Mow roadsides, if needed, when bahiagrass or dallisgrass seedheads begin to appear (usually in early June). Begin treatment when grasses begin to send up new seedheads. Air temperature in afternoons should be 80 degrees or above. Apply as needed when new seedheads or other weeds emerge usually at 4 to 6 week intervals. Two or three applications during the summer will be needed. This treatment suppresses bahiagrass, dallisgrass, johnsongrass and broadleaf weeds and allows fescue to remain with little injury. If bermudagrass is in the roadside, fescue may be gradually replaced.
Tall Fescue Seedhead Suppression and Weed Control	glyphosate (0.19 to 0.25 lb) + sulfometuron (0.012 lb)	Roundup Pro 4L (6 to 8 fl oz) + Oust 75DG (0.25 oz)	Roundup Pro + Oust may be applied to tall fescue roadsides to suppress tall fescue seedhead production. Apply to established, actively growing tall fescue in the spring <u>prior to seedhead emergence</u> (usually between March 1 and April 1). Slight discoloration of the fescue may occur. Roundup Pro + 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.
	sethoxydim (0.19 lb)	Vantage 1.0L (1.5 pt)	Vantage may be applied to tall fescue roadsides 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.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	chlorsulfuron (0.012 lb)	Telar 75DG (0.25 oz)	Telar may be applied to suppress tall fescue seedhead production. Apply to established tall fescue that is actively growing in the spring prior to seedhead emergence (usually between March 1 and April 1). Some suppression of the grass growth may occur. This treatment will also help to suppress or control many broadleaf weeds. This treatment may eliminate the need for mowing prior to the application in the summer of MSMA or DSMA as weed control treatments in fescue. Apply in 20 to 30 gallons of water per acre.
	glyphosate (0.19 to 0.25 lb) + chlorsulfuron (0.012 lb)	Roundup Pro 4L (6 to 8 fl oz) + Telar 75DG 0.25 oz	Roundup Pro + 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 (6 to 8 fl oz) + Escort 60 DG (0.25 oz)	Roundup Pro + 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.
Limb Trimming (side trimming)	fosamine (6 to 8 lbs)	Krenite 4S (1½ to 2 gal)	Add 1 qt crop oil per 100 gal. spray solution. Only controls treated (sprayed) limbs. Best to treat in late summer (Aug, Sep, Oct). Little foliage brownout occurs after treatment. Leaves drop off the tree in a normal fashion but are not produced the following spring. Use drift control as recommended on
	triclopyr (1 to 2 lbs)	Garlon 4 (4 to 8 qts)	This is a dormant application (Feb., Mar., April). Apply within 10 weeks prior to normal bud break. Add 3 gal crop oil per 100 gals spray solution. Only controls treated (sprayed) limbs. Use drift control as recommended on label.
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. Also used under guardrails, fences, signs, and bridge ends.
		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.
	fosamine (6 to 12 lbs)	Krenite 4S (1½ to 3 gal)	Used as a spot or broadcast treatment. Add nonionic surfactant at 1 qt/100 gals. Use 50 gal of water per acre as a broadcast application or 100 gal water per acre as a handgun application. Thorough plant coverage is necessary for control. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Read label for details. Controls kudzu, blackberry, sumac, multiflora rose, pines, and other woody plants.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	glyphosate (2 to 8.1 lb)	Rodeo 5.4L (2 to 1½ gal)	Used as a spot or broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal solution. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Thorough plant coverage is necessary for control. Also used for trimming, curbs, gutters, rip-rap, and drainage ditches.
	glyphosate (0.5 to 1.25 lb)	Roundup Pro 4L (2 to 5 qts) generic glyphosate 4L (3 to 7 pts)	Used as a spot treatment as treated grass will be damaged. Best results with late summer (Aug to Oct) treatments. Controls most annual weeds and many perennials such as johnsongrass, dock, milkweed, horsenettle, lespedeza, brambles, multiflora rose, and trumpet creeper. Apply on a spray-to-wet basis. Grass understory will be killed at the base of the spot treatment. Use a drift control agent as recommended on the label. Add 2 to 4 qts nonionic surfactant per 100 gal solution.
	glyphosate (5%) + imazapyr (0.5%)	Roundup Pro 4L (5 gal) + Arsenal 2S (2qt/100 gal)	Apply in a low volume backpack sprayer to the point of leaf wet. Do not spray to drip. Special precaution should be followed to avoid root application in areas of desirable trees and minimize the amount of herbicide to soil contact. Weak on waxy leaf brush.
Brambles	triclopyr (see trade name rates)	Garlon 3A (1½ to 3 qts)	Used as a spot treatment. Add 1 to 2 pts surfactant. Coverage should be to wet all leaves, stems, and root collars. Best control is with late summer treatments (Aug to Nov).
		Garlon 4 (1½ gal/100 gal solution)	Used as a spot treatment in 20 to 30 gal water per acre. Add 1 to 2 pts surfactant. Treat dormant brush with most of the foliage dropped (Jan through March).
	glyphosate (0.75 to 1 lb)	Roundup Pro 4L (3 to 4 qts)	Used as a spot treatment after plants have reached full leaf maturity. Best results with late summer (Aug to Nov) treatments. Generic glyphosate 4L may be used as a 1% solution (1 gal/100 gal spray solution). Add 2 to 4 qts nonionic surfactant per 100 gal spray for generic glyphosate.
	glyphosate (1 to 1.5% solution)	Roundup Pro 4L (1 to 1½ qts/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. Thoroughly spray foliage and stems without excessive runoff.
Cut stump/stubble	triclopyr (see trade name rates)	Garlon 3A (4 to 6 qts)	Used as a broadcast treatment. Add ¼ to ½% nonionic surfactant. Best results when application is made 4 to 8 months after mowing or hand cutting and vegetation is actively growing. Use drift control.
		Garlon 4 (20% solution = 5 gal/100 gal)	Used as a individual cut stump treatment. Add 25 gal Basal Oil per 100 gal spray. Used as a spot treatment in a squirt bottle, paint brush, or in a small hand held sprayer. Spray the root collar area, sides of the stump and the outer portion of the cut surface including cambium. Can be used on stumps for several weeks after cutting. Use a oil soluble dye. May be used year-round. May also be used during the dormant season (December through March) instead of Roundup Pro.
	triclopyr (1 lb)	Pathfinder II 1L (100% solution, ready to use)	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. Treat any time of year except when in standing water which prevents spray from reaching the ground.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	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.
	glyphosate (50% solution)	Roundup Pro 4L (1:1 water to herbicide ratio)	Treat May through Sept immediately following cutting. Apply using a backpack sprayer or squirt bottle. Remove wood chips before application. Treat only a outside perimeter of cut stump. This is the cambium tissue where the herbicide translocates in the plant. Use a water soluble dye. No drift control agent is needed.
Johnsongrass in bermudagrass	imazapic (0.188 to 0.35 lb)	Plateau 70DG (4 to 8 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, ragweed, sandspur, ragweed, tall fescue, prickly sida, trumpetcreeper. Use higher rate for later season treatment. To increase control, add MSMA at 2 lbs ai per acre. Do not mow prior to treatment or within 14 days after treatment.
	asulam (3.3 to 6.7 lb)	Asulox 3.34L (1 to 2 gal)	Broadcast treatment when grass is 18 inches or taller. Use higher rate in heavy infestations. A nonionic surfactant can be added at 0.25% by volume. DO NOT TREAT DESIRABLE CENTIPEDEGRASS.
	glyphosate (0.25 to 1% solution)	Roundup Pro 4L (¼ to 1 gal/100 gal)	Used as a spot treatment after plants have reached 12 to 18 inches in height. Add 2 qts nonionic surfactant per 100 gal solution. Best results with summer (June to Aug) treatments. Use higher rate with larger plants.
	glyphosate (0.5 to 3 lb)	Roundup Pro 4L (0.5 to 3 qts)	Used as a broadcast treatment. Add 2 qts nonionic surfactant per 100 gal spray solution. Use 1 pt/acre for burndown of smaller plants up to 12 inches tall. Use 2 to 3 qt/acre for larger plants in the boot to head stage. Best results with summer (June to Aug) treatments. Generic glyphosate 4L may also be used as a 0.75% solution (3 qts/100 gal spray) as a spot treatment. Use 3 to 4.5 pts/acre for broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal spray. Treat only actively growing plants (June through September).
	MSMA (2 lb) or DSMA (3.6 lb)	MSMA 6 L (a gal) or DSMA 3.6 L (1 gal)	May be applied April through August every 4 to 6 weeks for suppression or control of emerged weeds. Two to 3 applications may be needed for control. Apply in 40 gal per acre. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, johnsongrass, and several broadleaf weeds. Treat when johnsongrass is 12 to 18 in-tall. Tank mixing with Oust at 1 oz/acre during the first treatment will help provide preemergence seedling johnsongrass control. Do not add Oust to subsequent treatments.
	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.

Weed Control and Seedhead Suppression in Specialty Turf Areas Such as Roadsides, Industrial Sites, Fields, Common Areas (cont.)

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAME EXAMPLES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
	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. Add 0.5% nonionic surfactant (2 qts/100 gal spray) or methylated seed oil if Roundup Pro is not used. Treat May through for July when plants are small.
Ryegrass	prodiamine (0.65 to 1.5 lbs)	Endurance 65DF (1 to 2.3 lb)	These preemergence herbicides must be applied prior to ryegrass germination, usually by mid-Sept. Tank mix with Roundup Pro for control of emerged plants.
	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.
	glyphosate (0.3 + 0.6 lb) + 2,4-D (0.48 + 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Apply to dormant bermudagrass before March. High rate is needed unless ammonium sulfate (AMS) is added. With this combination, use Campaign at 1 qt/acre + AMS at 17 lbs per 100 gal of carrier. Apply in 20 to 40 gal water per acre. It is not necessary to add a surfactant to Campaign. Treat small weeds (<6-in tall) for best results. Since Campaign is a formulation containing 2,4-D, use care when applying in the vicinity of 2,4-D sensitive crops such as vegetables, cotton, tobacco, fruit trees, and ornamentals. Control is slow (2 to 4 weeks). Use appropriate drift control agent.
	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 or tank mixed with Oust and Telar for better control of broadleaf weeds. Bermudagrass greenup is not extensively delayed by this treatment.

Note: In portions of the United States, numerous weed species have developed resistance to members of the sulfonylurea herbicide family (e.g. Telar, Oust, Escort). Resistant biotypes are able to survive rates several times higher than needed to control susceptible biotypes. Roadside managers are encouraged to adhere to the following weed control practices to prevent the occurrence of sulfonylurea resistant weeds. 1. Tank mix sulfonylurea herbicides with herbicides that have a different mode-of action (e.g. Roundup, 2,4-D, etc.). 2. Do not let weed escapes go to seed in areas treated with sulfonylurea herbicide. 3. Respray problem areas with a herbicide that has a different mode-of-action than a sulfonylurea. 4. Rotate the use of sulfonylurea herbicides with herbicides that have a different mode-of-action

¹Spray equipment must be properly calibrated. A digital speed monitoring device helps maintain the correct ground speed of a 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.

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

SPRAY ADDITIVES

Product	Remarks
Surfactants	
Induce-F	Rate is ½ to 4 pts/100 gal spray. Low foam, nonionic surfactant for herbicide treatments.
Timberland 90	Rate is 1 to 4 pts/100 gal as a high volume ground spray or; 2 to 4 pts/100 gal as a low volume ground spray. Low foam, nonionic surfactant for herbicide treatments.
Other Surfactants	
Agri-Dex	Genepol 26-L-80 Cohort DC, Renex-30 X-77 + many others
Oil Concentrate	
Hygrade EC	Has extra emulsifiers to help maintain a solution.
Timbersurf 90	Crop oil. Crop oil formulated to mix with water-soluble herbicides such as Garlon 3A making a ready to use herbicide treatment. Follow label instruction for proper mixing.
JLB Oil Plus	Basal. Basal oil spray formulated to mix with oil-herbicides such as Garlon 4 making a ready to use herbicide treatment. Follow label instructions for proper mixing.
Methylated Seed Oil	
Sunwet	Best with herbicides for weed control and not for seedhead suppression products.
Drift Control Agents	
Ground Zero	Used with all herbicides at 3 to 4 oz/100 gal spray to maintain spray pattern and to prevent drift. Mix and use according to label directions.
Nalco-Trol, Exactrol, MORE	Do not use with Roundup Pro or Rodeo. These are drift control agents used with herbicides such as Garlon, MSMA, dicamba to maintain spray pattern. Follow label directions for mixing.
Nalco-Trol II, Detain II	Use with Roundup Pro or Rodeo. These are drift control agents used to maintain spray pattern. Follow label directions for mixing rates and instructions.
Miscellaneous Materials	
Blue Dye	Water based product. Mix according to label directions for spot and broadcast applications to indicate coverage.
Red Dye	Oil based product. Mix according to label directions for spot and broadcast applications to indicate coverage.
Foam Buster	Mix at 1 oz/100 gal spray prior to agitation. Follow label instructions for proper mixing.

Guide to Woody Plant Response to Herbicides*

Herbicides	Ash	Birch	Blackberry	Cedar	Dogwood	Elm	Greenbrier	Hawthorn	Hickory	Honey Locust	Honeysuckle	Kudzu	Maple	Mulberry	Multiflora Rose	Oaks	Persimmon	Pines	Poison Ivy	Poplar	Sassafras	Sumac	Sweetgum	Sycamore	Trumpet Creeper	Willow
2,4-D amine (FS)	P	F	F	P	P	F	P	F	F	P	P	P	P	P	P	F	P	P	P	F	P	F	P	F	P	P
2,4-D amine (CS)	P	F	P	P	F	G	P	F	F	F	P	P	P	F	P	F	F	F	F	G	G	F	F	F	F	G
2,4-D ester (FS)	P	–	P	P	P	P	P	–	P	P	P	P	P	P	P	P	P	P	P	–	P	F	P	–	P	P
Arsenal (FS)	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
Banvel (FS)	P	–	F	F	F	F	P	F	P	P	F	G	P	–	F	F	G	G	F	–	F	F	F	–	F	F
Crossbow (FS)	F	F	G	P	P	F	P	F	F	F	P	P	F	P	F	F	F	F	F	F	F	G	F	F	P	F
Escort (FS)	F	P	F	P	F	F	P	P	P	G	G	G	F	P	F	F	P	P	P	P	P	P	P	P	P	P
Garlon 3A (FS)	F	F	G	P	F	F	P	F	F	F	P	F	F	F	F	G	F	G	F	F	F	G	G	F	P	F
Garlon 4 (CS)	F	F	P	F	F	F	P	F	F	F	P	F	G	F	F	G	F	F	G	F	F	G	G	F	P	F
Garlon 4 (FS)	F	F	G	F	F	F	P	F	F	F	P	F	F	F	F	G	F	G	F	F	F	G	G	F	P	F
Garlon 4 (BS)	F	F	G	F	G	F	P	F	G	F	P	F	G	F	F	G	F	G	P	F	F	G	G	F	P	F
Krenite (FS)	F	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
Pathway	F	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
Roundup Pro (FS)	F	F	F	P	P	F	P	F	P	P	F	F	P	P	F	G	F	P	F	F	P	F	F	P	F	F
Roundup Pro (CS)	F	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
Weedmaster (FS)	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
Transline (FS)										G		G														

*G = Good

F = Fair (partial control or defoliation)

P = Poor

– = no data available

FS = Foliar Spray

BS = Basal Soil or Cut-Surface Spray only

CS = Cut Surface

ACTIVATED CHARCOAL FOR PESTICIDE DEACTIVATION

Bert McCarty

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

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

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

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

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

Example: Suppose Balan 2.5G was inadvertently applied at 2 pounds of active ingredient per acre to an area to be seeded with a turfgrass. To completely inactive this herbicide, an application of activated charcoal at 400 pounds per acre (or 9.2 pounds per 1000 square feet) would be needed. See **Table 26-2** for additional conversions of rates per acre to pounds per 1000 square feet.

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

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

Activated charcoal can be applied by various methods. It can be applied in the dry form with a drop spreader. However, activated charcoal particles are easily moved

by wind, so it may be difficult to distribute the charcoal evenly when applied in the dry form. The easiest method is to suspend the charcoal in water and apply it by hand with a watering can (for small areas) or a power sprayer. Because activated charcoal does not mix easily with water, a 0.5 % solution of a nonionic surfactant (equivalent to 1 quart per 50 gallons) will enhance its suspension in water. Note that charcoal particles are very abrasive and can damage spray equipment (particularly rotary type pumps). Therefore, if a sprayer is used to apply activated charcoal, care should be taken to thoroughly clean the equipment when finished.

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

Spray Application

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

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

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

Some suppliers of activated charcoal.

Powdered activated charcoal is available as 'Gro-Safe' from: American Norit Co., Inc. 1050 Crown Pointe Parkway Atlanta, GA 30338 1-800-641-9245	'Clean Carbon' activated charcoal is available from: Aquatrols 5 North Olney Ave. Cherry Hill, NJ 08003 1-800-257-7797
Flowable activated charcoal is available as '52 Pickup' from: Parkway Research Corp. 13802 Chrisman Road Houston, TX 77039 1-800-442-9821	

WEED CONTROL IN IRRIGATION WATER SUPPLIES

Lamar Robinette

Department of Aquaculture, Fisheries, and Wildlife

Aquatic weeds in ponds or lakes used as sources for irrigation water can be controlled by physical removal, triploid grass carp, or herbicides. The method, or combination of methods, used will depend on factors such as target weeds, non target plants, and what the water is used to irrigate.

Physical removal can be accomplished manually or with machinery. It is time consuming, expensive and normally used alone if other methods are not feasible. However, a certain amount of physical removal may be necessary in combination with the use of grass carp and herbicides.

Grass carp can be very effective for controlling many aquatic weeds, particularly the emerged ones. The major advantage is that there is no concern over damage to plants irrigated with herbicide treated water. Grass carp are usually used to control all vegetation in a pond, rather than selectively controlling certain vegetation. The most effective way to use grass carp is to initially control plants with a herbicide and then use grass carp to prevent regrowth of weeds. 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.

Diquat, endothall, glyphosate, fluridone, and copper compounds can be used safely in ponds used as irrigation sources if the manufacturer's label directions are followed. Certain waiting periods may be required before using water for irrigation after the herbicide is applied, while in some cases waiting periods are not required. Refer to the current herbicide label for this information.

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.
Hydrothol	0.3 to 3.4 gal/acre foot of 2L or 11 to 136 lb of 11G/acre foot.
Diquat	1 to 2 gal/surface acre of 2L.
2,4-D	1 to 2 gal/surface acre of 3.8 L or 150 to 200 lb of 20G/surface acre.
Copper Compounds	0.6 to 1.6 gal of Cutrine/acre foot or 0.1 to 0.3 ppm elemental copper.
Fluridone	0.375 to 0.5 gal/surface acre or 30 to 50 lb of 5P/surface acre.
Glyphosate	4.5 to 7.5 pt/surface acre of 5.4L.

*Acre foot = 1 surface acre of water 1 foot deep.

Effectiveness of Herbicides for Aquatic Weed Control.

Weed	Copper complexes, copper sulfate (various)	2,4-D (various)	Diquat (Reward)	Endothall		Fluridone (Sonar)	Glyphosate (Pondmaster, Rodeo)
				Aquathol K Aquathol G	Hydrothol G Hydrothol 191		
ALGAE							
Filamentous	E	P	P	—	G	P	P
Planktonic	E	P	G	—	G	P	P
Branched (Chara)	E	P	G	—	G	P	P
Nitella	E	P	G	—	G	P	P
FLOATING PLANTS							
Bladderwort	P	P	E	—	—	E	—
Duckweeds	P	G ¹	G	P	P	E	P
Water hyacinth	P	E	E	—	—	P	G
Watermeal	P	P	P	—	—	G	P
SUBMERSED PLANTS							
Broadleaf watermilfoil	P	—	E	E	E	E	P
Coontail	P	G	E	E	E	E	P
Egeria	P	P	G	F	F	E	P
Elodea	P	—	E	F	F	E	P
Eurasian watermilfoil	P	E	E	E	E	E	P
Fanwort	P	F	G	E	E	E	P
Hydrilla	F ²	P	G	G	G	E	P
Naiads	P	F	E	E	E	E	P
Parrotfeather	P	E	E	E	E	—	F
Pondweeds (Potamogeton)	P	P	G	E	E	E	P

Weed	Copper complexes, copper sulfate (various)	2,4-D (various)	Diquat (Reward)	Endothall		Fluridone (Sonar)	Glyphosate (Pondmaster, Rodeo)
				Aquathol K Aquathol G	Hydrothol G Hydrothol 191		
EMERSED PLANTS							
Alders	P	E	F	P	P	P	E
Alligatorweed	P	F	P	P	P	G	E
American locust	P	E	P	P	P	F	G
Arrowhead	P	E	G	G	G	--	E
Buttonbush	P	E	F	P	P	P	G
Cattails	P	G	G	P	P	F	E
Common reed	P	P	P	P	P	P	G
Fragrant & white waterlily	P	E	P	P	P	E	E
Frogbit	P	E	E	--	--	--	--
Maidencane	P	P	F	--	--	F	E
Most grasses	P	P	P	P	P	P	G
Pickerelweed	P	G	G	--	--	P	F
Pond edge annuals	P	--	G	--	--	E	E
Rush	P	P	F	P	P	F	E
Sedges and rushes	P	F	F	P	P	P	G
Slender spikerush	P	--	G	--	--	G	P
Smartweed	P	E	F	--	--	F	E
Spatterdock	P	E	P	P	P	E	G-E
Southern watergrass	P	P	--	--	--	G	E
Torpedograss	P	P	P	--	--	F	G
Watershield	P	E	P	--	--	G	G
Water pennywort	P	G	G	P	P	P	G
Water primrose	P	E	F	--	--	F	E
Willows	P	E	F	P	P	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.

¹Ester formulations only.

²Copper complex only.

Waiting Period (Days) Before Using Water After Application of Herbicides for Aquatic Weed Control

Common Herbicide Name Trade Name	Irrigation	Fish Consumption	Watering Livestock	Swimming
Copper Crystalline copper sulfate and various liquid organic copper complexes	NR ¹	NR	NR	NR
2,4-D Various formulations and manufacturers ²	Water use restrictions vary by formulation and manufacturer. In general, if water is used for irrigating sensitive crops, 2,4-D should not be used. Turfgrasses generally are tolerant to low concentrations of 2,4-D.			
Diquat Reward Weedtrine D	3 to 5 ³ 14	NR NR	1 14	NR 1
Endothall Aquathol K Aquathol granular Aquathol Super K Hydrothol 191 Hydrothol 191 granular	7 to 25 7 7 14 7	3 3 3 3 3	14 14 NR 14 14	NR 1 NR 1 1
Fluridone Avast, Sonar 4AS, Sonar SRP	7-30	NR	NR	NR
Glyphosate Rodeo, Aqua Neat, Eagre	NR	NR	NR	NR

¹NR = No restrictions.

²Most formulations do not permit application to ponds used for irrigation or for watering dairy cattle.

³Three days for irrigation of turf and nonfood crops; five days for irrigation of food crops (including tobacco) or for preparation of agricultural sprays.

Pesticide Calibration Formulas and Information
Bert McCarty

Acres covered/hour:	= MPH x Swath (ft) x 0.1212	or	$\frac{\text{MPH} \times \text{Swath (ft)}}{8.25}$
Gallons Per Acre (GPA):	= $\frac{\text{GPM} \times 495}{\text{MPH} \times \text{Swath (ft)}}$	or	$\frac{\text{GPM per nozzle} \times 495}{\text{MPH} \times \text{nozzle spacing (ft)}}$
	= $\frac{\text{GPM per nozzle} \times 5940}{\text{MPH} \times \text{nozzle spacing (inches)}}$	or	$\frac{\text{fl.oz. collected per nozzle} \times 4084}{\text{ft. traveled} \times \text{nozzle spacing (inches)}}$
	= $\frac{\text{fl.oz collected per nozzle in 100 ft} \times 40.8375}{\text{nozzle spacing (inches)}}$	or	$\frac{\text{gallons per 1000 sq.ft.}}{0.023}$
	= $\frac{\text{gallons collected per nozzle} \times \text{no. of nozzles} \times 43560}{\text{ft. traveled} \times \text{Swath (ft)}}$		
Gallons per 1000 sq.ft.	= 0.023 x GPA		
Ounces per 1000 sq.ft.	= 2.94 x GPA		
Gallons Per Minute (GPM):	= $\frac{\text{GPA} \times \text{MPH} \times \text{Swath (ft)}}{495}$	or	$\frac{\text{fl.oz per minute}}{128}$
	= $\frac{\text{GPA} \times \text{MPH} \times \text{nozzle spacing (inches)} \times \text{no. nozzles}}{5940}$		
GPM/Nozzle:	= $\frac{\text{GPA} \times \text{MPH} \times \text{nozzle spacing (inches)}}{5940}$	or	$\frac{\text{GPA} \times \text{MPH} \times \text{nozzle spacing (ft)}}{495}$
	= $\frac{\text{Test jar fl.oz} \times 0.46875}{\text{seconds to fill test jar}}$	or	$\frac{7.5}{\text{seconds to fill 1 pint (16 fl.oz.)}}$
	= $\frac{15}{\text{seconds to fill 1 quart (32 fl.oz.)}}$		
Minutes/Acre:	= $\frac{495}{\text{MPH} \times \text{Swath (ft)}}$	Acres covered per tank:	= $\frac{\text{Gallons per tank}}{\text{GPA}}$
Minutes/load:	= $\frac{\text{gallons/load} \times 495}{\text{MPH} \times \text{GPA} \times \text{Swath (ft)}}$	Material needed per tank	= $\frac{\text{rate/A} \times \text{gallons/tank}}{\text{GPA}}$
Travel Speed (Miles Per Hour, MPH)	= $\frac{\text{Distance traveled (ft)} \times 0.68}{\text{time (seconds) to travel distance}}$		

Flow Rate (as influenced by pressure):

$$\frac{GPM_1}{GPM_2} = \frac{\sqrt{PSI_1}}{\sqrt{PSI_2}} \quad \text{or} \quad GPA_2 = GPA_1 \times \sqrt{\frac{PSI_2}{PSI_1}} \quad \text{or} \quad PSI_2 = PSI_1 \times \left(\frac{GPA_2}{GPA_1}\right)^2$$

For any change in travel speed (mph), calculate the resulting GPA₂ by:

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

Fluid Application

$$\text{lbs/acre nutrient applied} = 0.226464 \times \text{element concentration (ppm)} \times \text{acre inches of solution applied}$$

$$\begin{aligned} \text{PPM} &= \frac{1,000,000 \times \text{lbs ai used}}{\text{gal/tank} \times 8.34} & \text{or} & \frac{\text{wt. of material to be used (lbs)} \times 1,000,000}{\text{wt. of tank mixture (lbs)}} \\ &= \frac{1,000,000 \times \text{oz commercial material used} \times \% \text{ ai (decimal)}}{\text{gal/tank} \times 8.34 \times 16} & \text{or} & \frac{1,000,000 \times \text{fl.oz. used} \times \text{lb ai/gal}}{\text{gal/tank} \times 8.34 \times 128} \end{aligned}$$

$$\text{lbs nutrients applied/acre} = \text{ppm of the element in the water} \times \text{acre-inches water applied} \times 0.226464$$

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

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

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

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

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

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

Active Ingredients (ai)

$$\begin{aligned} \text{lbs commercial material/acre} &= \frac{\text{lbs ai to be applied per acre}}{\% \text{ ai of material}} & \text{gal commercial material/tank} &= \frac{\text{gallons/tank} \times \text{lb ai to be applied per acre}}{\text{gallons/acre} \times \text{lbs ai per gallon}} \end{aligned}$$

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

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

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

Metric Prefix Definitions (basic metric unit = 1)

tera	=	10^{12}	deci	=	10^{-1}
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}

Approximate Rates of Application Equivalents

Weights

1 oz/ft ²	=	272.5 lbs/A	
1 oz/yd ²	=	302.5 lbs/A	
1 oz/100 ft ²	=	27.2 lbs/A	
1 oz/1000 ft ²	=	43.46 oz/A	= 2.72 lbs/A
1 lb/A	=	1 oz/273.3 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 bu shel	=	1¼ ft ³	= 0.046 yd ³

Liquid

1 oz/1000 ft ²	=	43.56 oz/A	= 1.4 qt/A
1 pt/1000 ft ²	=	5.4 gal/A	
100 gal/A	=	2.3 gal/1000 ft ²	= 1 qt/100 ft ²

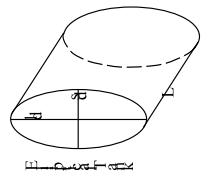
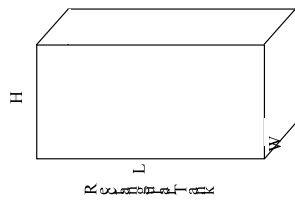
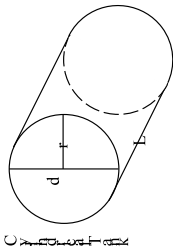
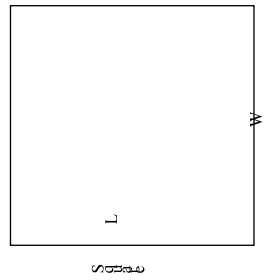
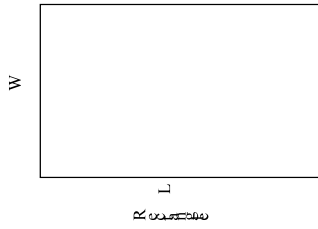
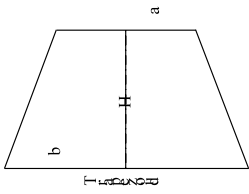
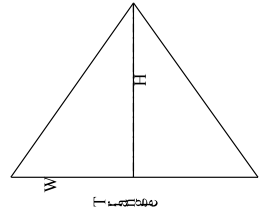
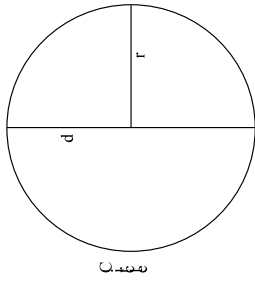
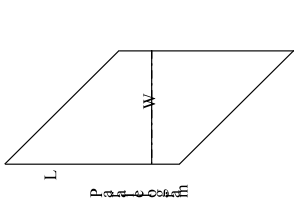
Helpful Calculations and Formulas:

Rectangle, square or parallelogram:	area	=	length (L) x width (W)	
Trapezoid:	area	=	[a + (b x h)] ÷ 2	
Circle:	area	=	radius (r) ² x 3.1416 (π)	= diameter (d) ² x 0.7854
	radius	=	d ÷ 2	
	diameter	=	0 r x 2	
	circumference	=	π x d	
Sphere:	volume	=	r ³ x 4.1888	= d ³ x 0.5236
Triangle:	area	=	(W x H) ÷ 2	
Cylinder:	volume	=	r ² x 3.1416 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



Metric System Conversion Factors

Area Equivalents

1 acre = 43,560 ft² = 4840 yd² = 0.4047 hectares = 160 rods² = 4047 m² = 0.0016 sq. mile

1 acre-inch = 102.8 m³ = 27,154 gal = 3630 ft³

1 hectare (ha) = 10,000 m² = 100 are = 2.471 acres = 107,639 ft²

1 cubic foot (ft³) = 1728 in³ = 0.037 yd³ = 0.02832 m³ = 28,320 cm³

1 cubic yard (yd³) = 27 ft³ = 0.765 m³

1 square foot (ft²) = 144 in² = 929.03 cm² = 0.09290 m²

1 square yard (yd²) = 9 ft² = 0.836 m²

Liquid Equivalents

1 ft³ of water = 7.5 gal = 62.4 lbs. = 28.3 liters

1 acre-inch of water = 27,154 gal = 3630 ft³

1 liter (l) = 2.113 pts. = 1000 ml = 1.057 qts. = 33.8 fl.oz. = 0.26 gal

1 US gallon = 4 qt. = 8 pt. = 16 cups = 128 fl.oz. = 8.337 lbs of water = 3.785 L = 3785 ml = 231 in³ = 256 tbsp. = 0.1337 ft³

1 quart = 0.9463 liters = 2 pt. = 32 fl. oz. = 4 cups = 64 tablespoons (tbsp.) = 57.75 in³ = 0.25 gal = 946.4 ml

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

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

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

1 milliliter (ml) = 1 cm³ = 0.34 fl.oz. = 0.002 pts

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

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

Temperature Equivalents

degrees Centigrade = (°F-32) x 5/9

degrees Fahrenheit = (°C x 9/5) + 32

Pressure Equivalents

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

1 PSI = 2.31 feet head of water

1 atm = 760 mmHg = 1.013 x 10⁵ Pa = 1.013 bar = 14.70 psi

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

Length Equivalents

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

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

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

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

foot = 0.3048 meters = 30.48 cm = 12 inches

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

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

Mixture Ratios

1 mg/g = 1000 ppm

1 fl.oz./gal = 7490 ppm

1 fl.oz./100 gal = 75 ppm

1 qt/100 gal = 2 tablespoons/1.0 gal

1 pt/100 gal = 1 teaspoons/1 gal

Flow

1 gpm = 0.134 ft³/minute

1 ft³/min. (cfm) = 449 gal/hr. (gph) = 7.481 gal/min

Weight Equivalents

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

1 metric ton = 10⁶ g = 1000 kg = 2205 lb

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

1 oz (weight) = 28.35 g = 0.0625 lb

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

milligrams (mg) = 0.001 grams

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

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

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

picogram = 10^{-12} grams

1 ppm = 0.0001% = 0.013 fl oz in 100 gal = 1 mg/kg = 1 mg/L = 1 $\mu\text{g/g}$ = 0.379 g in 100 gal water = 8.34×10^{-6} lb/gal = 1 $\mu\text{l/l}$

10 ppm = 0.001% = 10 mg/L

100 ppm = 0.01% = 100 mg/L

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

1 ppb = 1 $\mu\text{g/kg}$ or 1 $\mu\text{g/L}$ or 1 ng/g

1 ppt = 1 picogram/g

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

Approximate Weight of Dry Soil

Type	lbs/ft ³	lbs/acre (6 inches deep)
sand	100 (or 2700 lbs/yd ³)	2,143,000
loam	80-95	1,714,000
clay or silt	65-80	1,286,000
muck	40	860,000
peat	20	430,000

Sand weights (tons): = yd³ x 1.3

Gravel weights (tons): = ft³ x 110

0.5 to 1 inch diameter gravel \approx 2700 lbs/ton

0.25 to 0.375 inch diameter gravel \approx 3000 lbs/ton

Conversions for determining turfgrass irrigation needs.

1 acre-inch = 27,154 gal = 43,560 cu.in. = 3,630 cu.ft.

1 inch/1000 sq.ft. = 620 gal = 83 cu.ft.

1 gallon = 0.134 cu.ft. = 8.34 lbs

1 million gallon = 3.07 acre-feet

7½ gallons = 1 cu.ft. = 231 cu.in.

1 acre-foot = 325,851 gal = 43,560 cu.ft.

1 pound of water = 0.1199 gal

Precipitation rate (in/hr) = $\frac{\text{gpm} \times 96.3}{\text{area (ft}^2\text{)}}$

Energy

1 calorie (cal) = 4.184 Joule (J)

Joule (J) = 1 kg m² s⁻²

1 kcal = 4.184 kJ

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Acres	0.4047	Hectare (ha)
Acres	43,560	Sq. feet
Acres	0.00405	Sq. kilometer
Acres	4047	Sq. meter
Acres	4840	Sq. yards
Acre-feet	325,851	Sq. feet
Acre-feet	43560	Cu. feet
Acre-feet	1233.5	m ³
Acre-inch	102.8	m ³
Bar	14.5	Lb/in ²
Bar	1019.7	g/cm ³
Bar	29.53	inches Hg @ 0°C
Bar	75	cm Hg @ 0°C
Bar	0.001	J/kg
Bar	100	kPa
Bushels (dry)	0.03524	m ²
Bu	1.245	ft ³
Calorie (cal)	4.184	Joules (J)
Centimeters (cm)	0.03281	Feet
Centimeters	0.3937	Inches
Centimeters	0.1094	Yards
Centimeters	0.01	Meters
Centimeters	10	Millimeters (mm)
cm/sec	1.9685	ft/min
cm/sec	0.0223694	MPH
cm ²	0.001076	ft ²
cm ²	0.1550	in ²
cm ³	0.0610237	inch ³
cm ³	0.0338	fl oz
Cup	8	fl oz
Cup	236.6	cm ³
Feet (ft)	30.48	Centimeters
Feet	0.3048	Meters
ft ²	929	cm ²
ft ²	0.0929	m ²
ft ²	9.294 x 10 ⁻⁶	Hectares (ha)
ft ³ (cubic feet)	0.0283	Cu. meter
ft ³	7.4805	Gallons
ft ³	1728	Cubic inches
ft ³	0.037	Cubic yards
ft ³	28.32	L
Feet per minute	0.01136	MPH
Feet head of water	0.433	PSI
Foot candle	10.764	Lux
Gallons (gal)	3.785	Liters
Gal	3785	Milliliters

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Gal	128	Ounces (liquid)
Gal	0.13368	ft ³
Gal/acre	9.354	Liters/hectare
Gal/acre	2.938	Oz/1000 ft ² (liquid)
Gal/1000 ft ²	4.0746	L/100 m ²
Gal/minute	2.228 x 10 ⁻³	Cubic feet/second
Gal/min	0.06309	L/sec
Gal/min	0.227125	m ³ /hr
Grams (g)	0.002205	Pounds
Gram	0.035274	oz
G/cm ³	0.036127	lb/in ³
G/cm ³	62.428	lb/ft ³
G/ha	0.000893	lbs/a
G/ha	0.087162	oz/a
G/kg	0.10	percent (%)
Grams per liter	1000	PPM
Grams per liter	10	Percent
Grams/sq. meter	0.00020481	lb/sq. feet
Hectares (ha)	2.471	Acres
Ha	107,639	ft ²
Inches	2.540	Centimeters
Inches	0.0254	Meters
Inches	25.40	Millimeters
In ²	6.4516	cm ²
In ³	16.3871	cm ³
In ³	16.39	cm ³
In ³	0.55411	fl oz
In ³	0.01732	qt
Kilograms (kg)	2.2046	Pounds
Kg/hectare	0.892	Pounds/acre
Kg/ha	0.02048	lb/1000 ft ²
Kg/100 m ²	2.037	lbs/1000 ft ²
Kg/L	8.3454	lb/gal
Kilometers (Km)	100,000	Centimeters
Kilometers	3281	Feet
Kilometers	1000	Meters
Kilometers	0.6214	Miles
Kilometers	1094	Yards
Km/h	0.62137	MPH
Km/h	54.6807	ft/min
Kilopascals (kPa)	0.145	Pounds/sq.in. (psi)
Liters (L)	0.2642	Gallons
L	33.814	Ounces
L	2.113	Pints
L	1.057	Quarts
L	0.035315	ft ³

Metric Conversion Factors

To Convert	Multiply by	To Obtain
L/100 m ²	0.2454	gal/1 000 ft ²
L/100 m ²	1.9634	pt/1 000 ft ²
Liters/hectare	0.107	Gallons/acre
L/ha	0.314	oz/1 000 ft ²
L/ha	0.855	pt/A
L/min	15.85	gal/hr
Meters (m)	3.281	Feet
Meters	39.37	Inches
Meters	1.094	yards
Meters	100	Centimeters
Meters	0.001	Kilometers
Meters	1000	Millimeters
Meters/sec	2.2369	MPH
M ²	10.764	ft ²
M ²	1,550	in ²
M ²	1.196	yd ²
M ³	35.3147	ft ³
M ³	1.30795	yd ³
Miles (nautical)	1.1508	Miles (statute)
Miles (statute)	160,900	Centimeters
Miles	5280	Feet
Miles	1.609	Kilometers
Miles	1760	Yards
Miles/hour (mph)	1.467	Feet/second
Miles/hour	88	Feet/minute
Miles/hour	1.61	Kilometers/hour
Miles/hour	0.447	meter/second
Milliliters (ml)	0.0338	Ounces (fluid)
Milliliters	0.0002642	Gallons
ml/m ²	3.14	oz/1 000 ft ²
ml/10,000 L	0.0128	fl oz/1,000 gal
Millimeters (mm)	0.03937	Inches
1 mm Hg @ 0 C	0.13332	kPa
1 mm Hg	133333.3	mPa
Ounces (fluid)	0.02957	Liters
Ounces (fluid)	29.573	Milliliters
Ounces (fluid)	0.03125	qt.
Ounces (fluid)/acre	0.0731	L/ha
Ounces (fluid)/1000 ft ²	3.18	L/ha
Ounces (weight)	28.35	Grams
Ounces (weight)	0.0625	lb
Ounces (weight)/acre	0.07	kg/ha
oz (weight)/acre	11.473	g/ha
oz (weight)/1000 ft ²	3.05	kg/ha
oz (wt.)/ft ²	305.15	g/m ²
Percent (%)	10	g/kg

Metric Conversion Factors

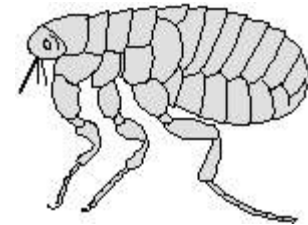
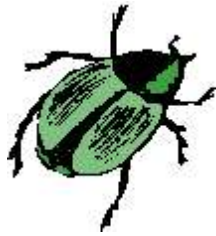
To Convert	Multiply by	To Obtain
Pint (liquid)	0.473	liter
pt/A	1.1692	L/ha
pt/A	0.3673	oz/1000 ft ²
pt/1,000 ft ²	0.50932	L/100 m ²
Parts per million (ppm)	2.719	lb ai/acre foot of water
PPM	0.001	Grams/l
PPM	8.34	lb/million gal
PPM	1	mg/kg
PPM	0.013	Ounces/100 gal of water
PPM	0.3295	Gal/acre-foot of water
PPM	8.2897	lbs/million gal of water
Pounds (lbs)	0.4536	Kilograms
Pounds	453.6	Grams
Pounds/acre	1.12	Kg/hectare
Pounds/A	1.0413	g/100 ft ²
Pounds/A	0.02296	lb/1000 ft ²
Pounds/sq.ft.	4883	Grams/sq.meter
Pounds/1000 ft ²	48.83	Kg/ha
Pounds/1000 ft ²	43.5597	lb/A
Pounds/yd ³	0.0005937	G/cm ³
Pounds/gallon	0.12	Kg/liter
PSI (lbs/sq.in.)	6.9	Kilopascals (kPa)
PSI	0.06895	Bar
PSI	0.068046	atm
PSI	2.31	feet head of water
PSI	6.89	kPa
Quarts	0.9463	Liters
Qt/A	2.3385	L/ha
Qt/A	0.7346	oz/1000 ft ²
Ton (2000 lbs)	907	kg
Ton (metric)	2,205	lb
Ton (metric)	1,000	kg
Ton (metric)	1.102	ton (2,000 lb)
Yards	91.44	Centimeters
Yards	0.9144	Meters
Yards	914.4	Millimeters
yd ³	27	ft ³
yd ³	0.7645	m ³
yd ³	765	L
yd ³ /1000 ft ²	0.825	m ³ /100 m ²
P ₂ O ₅	0.437	P
K ₂ O	0.830	K
CaO	0.715	Ca
MgO	0.602	Mg

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
C	0.1250	3.175
7/64	0.109375	2.778
1/10	0.100	2.540
3/32	0.09375	2.381
5/64	0.078125	1.984
1/16	0.0625	1.588
3/64	0.046875	1.191
1/32	0.03125	0.794
1/64	0.015625	0.397

Slopes

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



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Membership Application Information:

Individual Name: _____

Company/School Name: _____

Address: _____

City: _____

State _____ Zip _____

Home telephone _____

Work telephone _____

E-mail: _____

Dues Information:

Regular Member: \$35 ea.

Student Member: \$10 ea.

Send this to:

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Executive Director

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864-654-3166

