

EC 699



2005 Pest Control Guidelines for Professional Turfgrass Managers

This publication funded by the South Carolina
Turfgrass Foundation as a benefit for its members



2005 Clemson University Pest Control Guidelines for Professional Turfgrass Managers

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

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

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

CHEMTREC: 1-800-424-9300; <http://www.chemtrec.com/>

Provides emergency medical assistance for acute exposure to chemical and information on how to handle spills;

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/turforamental/

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

Southern Lawns - EC 707

Make check or money order payable to the **Clemson University** or for credit card orders call 864-656-3261 during weekday office hours or order on-line at: <http://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, & 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. **ISBN 1-57504-142-1.**

Managing Bermudagrass Turf A complete text concerning Bermudagrass Turf, especially golf greens. **ISBN 1-57504-163-4.**

Order these two from GCSAA.com; Amazon.com; or BarnesandNoble.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.orst.edu World Wide Web: <http://hpc.orst.edu/>

For larger pesticide spills, call 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

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 Start 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

Revised by Tim Davis
Extension Entomologist

Many insects can be found in a turfgrass area, but most of these do not damage the quality of the turf and some can even be beneficial to the overall ecology of the turfgrass system. There are, however a number of insects pests in turfgrass that can cause serious damage. In general, the location and damage can be lumped into three categories. First are insects that feed on or damage the leafy portion of the turfgrass. Common examples might include chinch bugs, spittlebugs, Bermudagrass mites, Sod webworms, armyworms, and other lawn caterpillars. The second group are insects that feed on or damage the roots of the turfgrass such as the mole crickets, white grubs, and billbugs. The third group of insects and related pests are found but cause no damage. They are often a nuisance because they bite, sting, migrate into houses, swimming pools, and damage equipment. Examples of nuisance insects include ants, fleas, ticks, millipedes, chiggers, sowbugs, and snails. While these insects are classified as nuisance pests, their potential impacts should not be minimized. For example the impact of the Red Imported Fire Ant upon irrigation equipment, electrical boxes, and mowing equipment can be substantial. The presence of stinging insects such as bees, wasps, hornets, and fire ants can raise serious liability issues as well. Risk of disease is also present for nuisance pests such as mosquitoes, ticks, and fleas.

The decision to treat for an insect pest can often be a complicated one. Such decisions must account for the economics of the treatment, environmental and ecological concerns, and the efficacy of the treatment. The only way to correctly make management decisions is to be well informed and use a knowledge based system to integrate the information concerning biology, ecology, environment, and chemistry into a single system. In the urban environment, economic thresholds are very difficult to define. Therefore, the following steps have been outlined as a framework for an IPM program: Identification, Monitoring, Evaluation, Prediction, and Decision.

Identification: 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. One of the most common reasons for treatment failures starts with misidentification of the pest. A correct identification not only provides information about what to treat with, but also when to treat, and how to treat. The County Extension office can help with pest identification via the Plant Problem Solving Clinic. Giving a name to the pest is not the only function of identification. By having the correct name, information about the life history of the organism can also be researched. Such information can be important in the monitoring step and the prediction step of the urban IPM program.

Monitoring: Monitoring is the process of looking for pest problems, and is sometimes called “scouting”. For many insect pest problems finding them early and treating early is the key to success, therefore, regular scouting is critical. Knowing the problems that are most likely to occur can help in designing a monitoring program. Monitoring can also be reactive or proactive. An example of a reactive monitoring program might be the mapping of mole crickets or white grubs to determine the area and level of infestations. Proactive monitoring programs might use traps to determine peak levels of activity and target further monitoring to the optimum time frame for treatments.

Some examples of monitoring techniques:

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 clean water. Wait 5 minutes for chinch bugs to float to top of water. Similar results can be obtained by cutting plugs and placing them in a 5 gallon bucket then filling the bucket with clean water. *Note: do not use soapy water when sampling for chinch bugs.* If none are present, visually examine at 3 to 4 sites in the suspected area along the margin of the damaged area. 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 2 gallons of water and drench a 4 sq. ft. 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.

Traps: Pheromone traps and fly way traps are not usually useful as a tool for reducing pest populations. They are, however, useful as monitoring tools. For example, the optimum time to treat for white grubs is three to four weeks after the peak of the mating flight. As this time can vary from year to year and from one location to another, pheromone trapping may be a useful tool for determining the best time to make applications.

Evaluation, Prediction, and Record Keeping: Accurate record keeping of monitoring/scouting programs, particularly long term records, can allow detailed evaluation of the management techniques used and their efficacy. They can also provide the manager with the necessary tools to predict the time and location of pest outbreaks. Over time, they can save time and money

by targeting monitoring efforts and treatments only to “at risk” sites. Detailed records can also be invaluable to the specialist or consultant when special problems are confronted. Records should include as much detailed information as possible, for example, the number and types of pests, the location, the date, type of damage, cultural practices, environmental conditions, turf species and cultivar and so on. Provide actual numbers i.e. how many of pest species A per square yard, temperature in degrees Fahrenheit, rather than high or low infestation or hot and dry. After treatments, go back to the monitoring techniques to determine whether treatments worked or not, or for how long did they work.

Decision: The decisions regarding treatments are often very complex and difficult. Choices need to be made regarding the impact of the treatment vs. non-treatment. Economic and efficacy factors should also play an important role in any decisions that are made. Chemical insecticide treatments should be used as a last resort, though they are often the only choice for many pests. A strong healthy stand of turfgrass is the best defense against any pest problem. The benefits of following best management practices should not be minimized.

Notes on Insecticide Use Issues:

Active Ingredients and Formulations: Frequently, numerous formulations are available for the same active ingredient, but each formulation may have different uses on their labels. Changes in formulation can alter the method of application, the efficacy, the target pest etc. For example, fipronil formulations for the Red Imported Fire Ant include Top Choice, Ceasefire, and Over ‘n Out. Each of these products works a little differently and there are differences in the sites where these can be applied, application methods, and target pests. The formulation can also alter the means by which the pest or pests are targeted. Price alone should not be the deciding factor for which product to purchase. *Read the label carefully before making decisions, regarding the purchase or application of insecticides* to determine if they are suitable for your particular site.

Application Rates: The correct application rate is always the rate found on the label of the product you have in hand. Rates can vary based upon the target species, the retailer, manufacturer, distributor, or manufacture date. *Rates can often change without warning so it is important to read the label each time you use the product.* The rates provided in this manual are at best guidelines and are not intended to be authoritative.

Site restrictions: Many insecticides have site restrictions. For example they might say “For general insect control in turfgrass areas including athletic fields and parks and residential, commercial, institutional, and recreational lawns. Not for use on golf courses or sod farms”. *Read the label carefully before making decisions, regarding the purchase or application of insecticides* to determine if they are suitable for your particular site.

Buffer zones: Many products are adding buffer zones particularly with respect to water quality protection issues. *Read the label carefully before making decisions, regarding the purchase or application of insecticides* to determine if they are suitable for your particular site.

SPECIAL NOTE: Diazinon has been removed from the recommendations due to its ongoing phase out. The last date for retail sale was December 2004. End-use products in the hands of consumers do not have to be returned to the dealer/retailer. They can be used up according to the label. Questions regarding Diazinon should be directed to Syngenta at 1-800-334-9481.

Pesticide Application Information – While the label is the law, the following sources may be helpful when seeking information regarding specific pesticide products.

- Department of Pesticide Regulation (DPR) <http://drpsp.clemson.edu>
- Pesticide Information Page <http://entweb.clemson.edu/pesticide/index.htm>
- Environmental Protection Agency (EPA) <http://www.epa.gov/pesticides/>
- Clemson Entomology Department <http://entweb.clemson.edu> contains downloadable fact sheets on many common insect pests

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
Armyworms	Astro	0.4 to 0.8 fl oz	<p>Fall Armyworm (FAW) populations fluctuate greatly from season to season. Though the last few seasons they have been more frequent problems. FAW does not over winter in SC and migrates north from FL and Southern GA. For this reason problems rarely appear until June, but problems can persist throughout the rest of the season. Eggs are laid in masses on almost any structure. At egg hatch the larvae migrate and begin to feed. Damage is rarely noticed until the last instar (stage of development) when the larvae are relatively large and difficult to control. Larvae often sequester during the day making them difficult to find until they have already damaged the turfgrass. The presence of birds that feed on the caterpillars may also be an indicator for closer inspections. In some cases the birds feeding on the worms can actually do more damage than the worms themselves.</p> <p>Pheromone traps for FAW are commercially available. The presence of adult moths in a trap should be an early warning to begin monitoring for early larval activity. Larvae are much easier to manage when they are very small. A detergent flush consisting of 1 to 2 fl oz detergent per gallon of water, will aid in detecting low populations and small larvae. Damage to turf usually occurs when more than 5 or 6 caterpillars per square yard. Treatment is also needed when droppings or damage are apparent. In cases with severe damage and larvae are not apparent, try looking for the pupae in the soil below the turf.</p> <p>Dursban for use on golf courses, road medians, and industrial plants sites only.</p> <p>Mach 2 2SC for use on commercial turfgrass sites only.</p> <p>Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.</p>
	Allectus G	See label	
	Allectus GC	See label	
	Onyx	See label	
	<i>Bacillus thuringiensis</i> (Dipel DF, 2X; Biobit HP; Javelin WG; XenTari)	See label	
	Battle GC T&O or Scimitar GC or CS	3.4 to 7 ml	
	Conserve SC	0.25 to 1.2 fl oz	
	Dursban PRO	1.5 fl oz	
	DeltaGard GC 5SC	0.2 to 0.4 fl oz	
	DeltaGard GC Granules	2 to 3 lb	
	Demand CS	3.4 to 7 ml	
	Mach 2 2SC	1.5 fl oz	
	Mach 2 1.5G	1.55 lbs	
	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	
	Talstar One	0.18 to 0.25 oz	
	Talstar EZ or EZ Golf Granular	1.15 lbs	
	Talstar GC or PL Granular	1.15 lbs	
Talstar GC Flowable	0.25 to 0.5 oz		
Tempo SC Ultra	4 to 8 ml		
Tempo Ultra WP	5 to 10 grams		
Tempo 20 WP GC	55 grams/11,000 sq ft		
Billbugs	Battle GC T&O	7 ml	
	Scimitar GC or CS	7 ml	
	Allectus G	See label	
	Allectus GC	See label	
	Onyx	See label	
	DeltaGard GC or T&O 5SC	0.6 to 0.9 fl oz	
	DeltaGard GC or T&O Granules	2 to 3 lbs	
	Demand CS	7 ml	
	Dursban PRO	1.5 fl oz	
	Mach 2 Liquid	2.9 fl oz	
	Mach 2 2SC	3.0 lbs	

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
	Mach 2 1.5G Merit 2F Merit 75 WP Merit 0.5 G Sevin 10G Sevin 80WSP Sevin SL Talstar EZ or EZ Golf Granular Talstar One Talstar GC Granular & PL Granular Talstar GC Flowable Tempo SC Ultra Tempo Ultra WP Tempo 20 WP GC	4.2 to 5.6 grams See label See label 1.4 to 1.8 lbs 1.9 lbs 10 lb/acre 6 fl oz 1.15 to 2.3 lbs 0.25 to 0.5 fl oz 1.15 to 2.3 lbs 0.25 to 0.5 oz 8 ml 10 grams 55 gms per 7800 sq.ft	Mach 2 and Merit are preventative rather than curative in nature. These products need to be applied prior to or at egg hatch. Talstar and Tempo are for adult billbug control only. Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.
Chinch Bugs	Astro Battle GC T&O or Scimitar GC or CS Allectus G Allectus GC Onyx DeltaGard GC 5SC DeltaGard GC Granule Granules Demand CS Dursban PRO Merit 0.5 G Merit 2 E Merit 75 WP Orthene Turf, Tree & Ornamental Spray Pinpoint 15G Sevin 10G Sevin 80 WSP	0.4 to 0.8 fl oz 14 ml See label See label See label 0.6 to 0.9 fl oz 2 to 3 lbs 14 ml 1.5 fl oz 1.8 lbs 0.6 fl oz 5.6 grams 1.2 to 2.4 oz 0.6 to 0.75 lbs 1.4 to 1.9 lbs 7.5 to 10 lb/acre	Chinch bugs are a major problem on St. Augustinegrass. When chinch bugs are found on other turfgrass species they are often planted near St. Augustinegrass. Hot, dry weather, deep thatch, and high fertility favor chinch bug development. Sampling for chinch bugs is conducted using the floating method. Plugs of turf and soil can be placed in a 5 gallon bucket filled with clean water or an open ended cylinder driven into the ground filled with clean water. Adults and nymphs will float to the surface within 10 minutes. Do NOT use soapy water. For best result sample along the edge of the damage. If chinch bugs are suspected and floating yields no results, visual examination of the stolens in the thatch layer may yield results. Treatments should be applied if 25 to 30 insects are found per square foot. Chinch bugs are often found in the thatch layer. Thus spray volume is critical to successful insecticide treatments. See insecticide label for specifics. In general, use a minimum spray volume of 50 gallons/acre (1.2 gallons/1000 sq. ft.). St. Augustinegrass varieties Floratam' or 'Floralawn' are reported to have some resistance to chinch bugs. Cultural controls include less N, using water insoluble (slow release) N, using a sharp mower blade, mowing at 3" in sun areas, 4" in shaded areas, and controlling thatch. Irrigate with ¾-inch when grass begins to wilt. Minimize the use of atrazine on St. Augustinegrass during summer. Monitor turf regularly. To preserve beneficial arthropods, spot treat the damaged area and 5 to 10 feet beyond. Recheck in 2-3 days. Spot treat again, if needed. Dursban for use on golf courses, road medians, and industrial plants sites only. Merit provides suppression of chinch bugs. Irrigate Sevin products <i>prior</i> to application, but do not irrigate 24 hrs. <i>after</i> application

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
	Sevin SL Talstar One Talstar EZ or EZ Golf Granular Talstar GC or PL Granular Talstar GC Flowable Tempo SC Ultra Tempo Ultra WP Tempo 20 WP GC	4.4 to 6 fl oz 0.25 to 0.5 fl oz 2.3 to 4.6 lbs 2.3 to 4.6 lbs 0.25 to 0.5 oz 8 mls 10 grams 55 grams/11,000 sq. ft.	Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet.
Cutworms	<i>Bacillus thuringiensis</i> (Dipel DF, Javelin WG, XenTari) Allectus G Allectus GC Onyx Battle GC T&O or Scimitar GC or CS Conserve SC DeltaGard GC 5SC DeltaGard GC Granules Demand CS Dursban PRO Dylox 6.2G Advanced Lawn 24 Hour Grub Control Mach 2 1.5G Mach 2 2SC Merit 75WP Merit 0.5 G Merit 2F Orthene Turf, Tree & Ornamental Spray Sevin 10G Sevin 80 WSP Sevin SL Talstar EZ or EZ Golf Granular Talstar GC Flowable Talstar GC or PL Granular Talstar One Tempo SC Ultra Tempo Ultra WP Tempo 20 WP GC	See label See label See label See label 3.4 to 7 ml 0.8 to 1.2 fl oz 0.2 to 0.4 fl oz 2 to 3 lbs 3.4 to 7 ml 1.5 fl oz 2 lbs 1.55 lb 1.5 fl oz 4.2 to 5.6 grams 1.4 to 1.8 lbs See label 1.2 to 2.4 oz 0.9 lbs 2.5 to 5 lb/acre 1.5 to 3 fl oz 1.15 lbs 0.23 to 0.46 oz 1.15 lbs 0.23 to 0.46 oz 4 to 8 ml 5 to 10 grams 55 grams/11,000 sq ft	Cutworm larvae usually spend the day in burrows. Damage is usually most apparent on golf greens where the burrows are easily visible and can interfere with the playing surface. The adult cutworm moth lays her eggs individually on the grass blades. Frequent mowing can significantly impact the cutworm population, however, this is rarely enough to control the population. Removal of clippings further away from site is also recommended. Cutworms can migrate as much as 50 ft in less than 24 hours, thus a barrier treatment around the greens may reduce migrations onto greens. A detergent flush consisting of 1 fl oz liquid detergent per gallon of water can be used to sample larvae. The presence of birds that feed on the caterpillars may also be an indicator for closer inspections. In some cases the birds feeding on the worms can actually do more damage than the worms themselves. Treatments should be applied when damage and larvae are present. Late afternoon applications are most effective. Some products require irrigation to activate. See label of specific materials for details. Dursban for use on golf courses, road medians, and industrial plants sites only. Mach 2 2SC and Mach 2 1.5G are “molt accelerating compounds”. They work by interfering with the larval molting process. To be effective, the earliest stages must be treated, thus an effective monitoring program is needed for best results. Mach 2 2SC for use on commercial turfgrass sites only. Formulations of Mach 2 and Merit are preventative rather than curative in nature. These products need to be applied prior or at egg hatch to be effective. For advanced infestations, curative products will be a better choice. Do not irrigate treated (Sevin products) area within 24 hrs following application. Do not irrigate treated area following Tempo application for 24 hrs. Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet.
Ground	No effective insecticide is available at the present time.		This scale insect feeds on the roots of Bermudagrass, St. Augustinegrass, zoysiagrass, and centipedegrass. All stages occur

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
Pearls			on roots. Most of the stages are well-protected in a pearl-like cyst. When no insecticides are available for the pest, the best defense is sound turf management. Follow best management practices including proper fertilization, mowing heights, and irrigation to grow healthy turf.
Mites: Bermudagrass & Clover	Dursban Pro Kelthane 50 WSP Onyx Talstar GC Flowable Talstar One	1.5 fl oz 0.5 to 1 lb per acre See label 0.25 to 0.5 fl oz 0.25 to 0.5 fl oz	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. Do not use Kelthane on residential lawns. Dursban for use on golf courses, road medians, & industrial plants sites only. Talstar is labeled only for clover mite control.
Mole Crickets	Battle GC T&O or Scimitar CS or GC Chipco Choice 0.1% G ² Allectus G Allectus GC Onyx Chipco TopChoice DeltaGard GC 5SC DeltaGard GC Granules Demand CS Dylox 6.2 G Advanced Lawn 24 Hour Grub Control Merit 75WP Merit 0.5G Merit 2F Advanced Lawn Season-Long Grub Control Orthene Turf, Tree & Ornamental Spray Pinpoint 15G Sevin Baits Talstar EZ or EZ Golf Granular Talstar GC Granular Talstar GC Flowable Talstar One Talstar PL Granular Talstar GC Mole Cricket Bait Tempo SC Ultra Tempo Ultra WP Tempo 20 WP GC	7 - 14 ml 122 to 25 lbs/A See label See label See label 2 lbs 0.6 to 0.9 fl oz 2 to 3 lbs 7 to 14 ml 3 lbs 5.6 grams 1.8 lbs See label 3.8 lbs 1 to 1.9 oz 0.45 to 0.75 lb See Label 2.3 to 4.6 lbs 2.3 to 4.6 lbs 0.5 to 1 fl oz 0.5 to 1 fl oz 2.3 to 4.6 lbs 6 ml 8 mls 10 grams 55 grams/7,800 sq ft	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. 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 2" 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 : 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 2 inch water (except Orthene). Apply as late in late afternoon as possible. 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. Tempo 20 WP GC is a water soluble packet formulation where 55 grams equals one packet.
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.

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
	<i>Bacillus thuringiensis</i> (Dipel DF, Javelin WG, XenTari) Allectus G Allectus GC Onyx Battle GC T&O or Scimitar GC or CS Conserve SC DeltaGard GC 5SC Demand CS Dursban PRO Dylox 6.2G Advanced Lawn 24 Hour Grub Control Mach 2 Granular Mach 2 Liquid Orthene Turf, Tree & Ornamental Spray Sevin 10G Sevin 80WSP Sevin SL Talstar EZ or EZ Golf Granular Talstar GC Granular Talstar GC Flowable Talstar One Talstar PL Granular Tempo SC Ultra Tempo Ultra WP Tempo 20WP GC	See label See label See label See label 3.4 to 7 ml 0.25 fl oz 0.2 to 0.4 fl oz 3.4 to 7 ml 1.5 fl oz 2 lbs 1.55 lbs 1.5 fl oz 0.5 to 1.2 oz 1.4 to 1.9 lbs 7.5 to 10 lbs/acre 4.4 to 6 fl oz 1.15 lbs 1.15 lbs 0.25 fl oz 0.23 to 0.46 oz 1.15 lbs 4 to 8 ml 5 to 10 grams 55 grams/11,000 sq ft	<p>Dursban for use on golf courses, road medians, and industrial plants sites only.</p> <p>Mach 2 2SC for use on commercial turfgrass sites only.</p> <p>Formulations of Mach 2 and Merit are preventative rather than curative in nature. These products need to be applied prior or at egg hatch to be fully effective.</p> <p>Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.</p>
Spittlebugs	Orthene Turf Tree & Ornamental Spray Onyx Sevin 10 G Sevin 80WSP Allectus G Allectus GS Sevin SL Tempo SC Ultra	1 to 1.9 oz See label 1.4 to 1.9 lbs 2.5 to 5 lbs See label See label 12 to 3 fl oz 45 to 160 mls/100 gals	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.
White Grubs	Advanced Lawn Season-Long Grub Control Dylox 6.2 G Allectus G Allectus GC	2.87 lbs See label See label See label	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 2-inch after application. See label directions.

INSECT PEST CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq.ft.	Cultural Practices and Comments
	Dylox 80	See label	Mach 2 2SC for use on commercial turfgrass sites only. Formulations of Mach 2 and Merit are preventative rather than curative in nature. These products need to be applied prior or at egg hatch. For advanced infestations curative products will need to be applied.
	Advanced Lawn 24 Hour Grub Control	3 lb	
	Mach 2 Liquid	2.9 fl oz	
	Mach 2 Granular	3.0 lbs	
	Merit 75WP	4.2 to 5.6 grams	
	Merit 2F	See label	
	Merit 0.5G	1.4 to 1.8 lbs	
	Sevin 10G	1.9 lbs	
	Sevin 80WSP	10 lb/acre	
	Sevin SL	6 fl oz	

Comparison of Insecticides Registered for Mole Cricket Control in Turf.

Material	Formulation	Residual	Comment
Chipco Choice	0.1%G	very long	Slit applications only. Caution use label.
Chipco TopChoice	0.0143%G	long	Broadcast application, water-in, 4 months control
Merit	75WP, 0.5G	intermediate	Several formulations for various sites.
Advanced Lawn Season Long Grub Control	0.2G	intermediate	Best for nymphs, apply at egg hatch.
Battle/Scimitar/Demand	0.88 EC	intermediate	Best for nymphs, apply at egg hatch.
Advanced Lawn 24 Hour Grub Control	6.2G	intermediate	Low odor; controls nymphs and adults
Orthene, Pinpoint, Velocity	75, 15G	short	Standard for nymphs in summer.
Baits:			
Sevin	5%	short	Good for mid- and late season nymphs.

NUISANCE PESTS - CHEMICAL CONTROLS

Pest	Pesticide Formulation ¹	Formulation Rate/1,000 sq. ft.	Cultural Practices and Comments
Ants	Astro	0.4 to 0.8 fl oz	<p>More than 110 species of ants have been recorded in South Carolina. Less than 20 species are known to cause problems. In most cases ants are beneficial, serving as insect predators. Also a number of studies show that when numbers of native ant species are high they can have a negative impact of Red Imported Fire Ant populations.</p> <p>Ants can at times, however build up high numbers so that treatments may be deemed necessary. In such cases identification of the species causing the problem is critical as the biology can vary greatly from one species to another. An understanding of the biology is often critical in knowing where to treat and what to treat with, especially when baits are used. Ants are very susceptible to insecticide treatments, but relief of the problem seldom occurs unless the colony itself is eliminated.</p> <p>NOTE: 5% Malathion or 5% Sevin dust may also be used for ant control.</p> <p>Dursban for use on golf courses, road medians, and industrial plants sites only.</p> <p>Use Orthene as a spot treatment for ants.</p> <p>Tempo 20WP GC is a water soluble packet formulation where 55 grams equals one packet.</p>
	Battle GC T&O or Scimitar GC or CS	3.4 to 7 fl oz	
	Allectus G	See label	
	Allectus GC	See label	
	Onyx	See label	
	DeltaGard GC 5SC	0.4 to 0.6 fl oz	
	DeltaGard GC Granular	2 to 3 lbs	
	Demand CS	3.4 to 7 ml	
	Dursban Pro	1.5 fl oz	
	Orthene Turf, Tree & Ornamental	1.6 oz/gal	
	Pinpoint	See label	
	Sevin 10G	1.4 to 1.9 lbs	
	Sevin 80WSP	2.5 to 5 lbs	
	Sevin SL	1.5 to 3 fl oz	
	Talstar EZ or EZ Golf Granular	2.3 to 4.6 lbs	
	Talstar GC Flowable	0.25 to 1.0 oz	
	Talstar GC Granular & PL Granular	2.3 to 4.6 lbs	
	Talstar One	0.5 to 1.0 oz	
	Tempo SC Ultra	4 to 6 ml	
	Tempo Ultra WP	5 to 10 grams	
Tempo 20WP GC	55 gms/11,000 sq ft		

NUISANCE PESTS - CHEMICAL CONTROLS

Pest	Pesticide Formulation¹	Formulation Rate/1,000 sq. ft.	Cultural Practices and Comments
Snails Slugs	Deadline Bullets Metaldehvde 7.5G	0.5 to 2 lbs 6.4 oz	For best results, apply in evening following rain or irrigation. Reapply every 3-4 weeks. 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 Allectus G Allectus GC Sevin 10G Sevin 80 WSP Sevin SL Talstar EZ or EZ Golf Granular Talstar GC or PL Granular Talstar One Talstar GC Flowable Tempo SC Ultra	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 See label See label 1.6 to 1.9 lbs 2.5 to 5 lb/acre 1.5 to 3 fl oz 2.3 to 4.6 lbs 2.3 to 4.6 lbs 0.5 to 1.0 fl oz 0.5 fl oz 4 - 8 mls	Chiggers (red bugs) and ticks may be present in turfgrass areas. Apply controls as needed. Follow label directions. Astro, Scimitar GC and Talstar are only for tick control. Dursban for use on golf courses, road medians, and industrial plants sites only. Use 8 ml rate of Tempo for chigger control.
Fleas	Astro Battle GC T&O or Scimitar GC or CS DeltaGard GC 5 SC Dursban Pro Allectus G Allectus GC Onyx Orthene Turf, Tree & Ornamental Talstar EZ or EZ Golf Granular Talstar GC Flowable Talstar GC and PL Granular Talstar One	0.4 to 0.8 fl oz 3.4 to 7 ml 0.4 to 0.6 fl oz 1.5 fl oz See label See label See label 1.2 to 2.4 oz 2.3 to 4.6 lbs 0.23 to 0.46 oz 2.3 to 4.6 lbs 0.5 - 1.0 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 One	1.6 oz/gal water 0.25 to 0.5 fl oz	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.

Cross reference table of insecticides for major turfgrass pests.

Insecticide	Armyworms	Bermudagrass Mites	Billbugs	Clover Mites	Cutworms	Fire Ants	Leafhoppers	Mole Crickets	Sod Webworms	So. Chinch Bugs	Spittlebugs	White Grubs
Advanced Lawn 24 Hour Grub Control					yes			yes	yes			yes
Advanced Lawn Season-Long Grub Control								yes				yes
Advion Fire Ant Bait						yes						
Allectus G	yes		yes		yes	yes	yes	Yes	yes	yes		yes
Allectus GC	yes		yes		yes	yes	yes	yes	yes	yes		yes
Amdro Pro						yes						
Astro	yes					yes	yes	yes	yes	yes	yes	
Award Fire Ant Bait						yes						
<i>Bacillus thuringiensis</i> (Dipel, Javelin, XenTari)	yes				yes				yes			
Battle GC	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Ceasefire Fire Ant Bait						yes						
Chipco Choice, TopChoice						yes		yes				
Conserve SC	yes				yes				yes			
DeltaGard	yes	yes	yes		yes	yes	yes	yes	yes	yes	yes	
Demand			yes	yes		yes	yes	yes	yes	yes	yes	
Diazinon AG600, 50W, 5G	yes	yes	yes	yes	yes	yes	yes		yes	yes		yes
Distance Fire Ant Bait						yes						
Dursban PRO	yes	yes	yes	yes	yes	yes	yes		yes	yes		
Dursban Granular Bait, 1%	yes			yes	yes	yes	yes		yes	yes		
Dylox					yes			yes	yes			yes
Justice Fire Ant Bait						yes						

Cross reference table of insecticides for major turfgrass pests.

Insecticide	Armyworms	Bermudagrass Mites	Billbugs	Clover Mites	Cutworms	Fire Ants	Leafhoppers	Mole Crickets	Sod Webworms	So. Chinch Bugs	Spittlebugs	White Grubs
Kelthane		yes		yes								
Logic						yes						
Mach 2	yes		yes		yes				yes			yes
Merit 75WP, 0.5G			yes		yes		yes	yes		yes	yes	yes
Nematac S								yes				
Orthene TT&O	yes				yes	yes	yes	yes	yes	yes	yes	
Pinpoint 15G	yes				yes	yes		yes	yes	yes	yes	
Scimitar GC or CS	yes		yes	yes	yes	yes	yes	yes	yes	yes		
Sevin 10G	yes		yes		yes	yes	yes		yes	yes	yes	yes
Sevin 80 WSP	yes		yes		yes	yes	yes		yes	yes	yes	yes
Sevin SL	yes		yes		yes	yes	yes		yes	yes	yes	yes
Talstar F and G formulations	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Onyx	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	
Tempo SC ultra, Ultra WP, & 20WP GC	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes	
Varsity Fire Ant Bait						yes						

Cross reference table of insecticides for nuisance turfgrass pests.

Insecticide	Ants	Chiggers (Red Bugs), Ticks	Imported Fire Ants	Fleas	Centipdes, Millipedes, Pillbugs, Sowbugs	Snails, Slugs	Wasps, Bees
Advanced Lawn 24 Hour Grub Control			yes				
Advion Fire Ant Bait			yes				
Amdro Pro	yes		yes				
Astro	yes		yes	yes	yes		yes
Award Fire Ant Bait			yes				
Battle GC	yes	yes	yes	yes			
Ceasefire Fire Ant Bait			yes				
Chipco Choice, TopChoice	yes	yes	yes	yes			
DeltaGard	yes	yes	yes	yes	yes		
Diazinon AG600, 50W, 5G	yes	yes	yes	yes	yes		yes
Distance Fire Ant Bait			yes				
Dursban PRO	yes	yes	yes	yes	yes		yes
Justice Fire Ant Bait			yes				
Logic			yes				
Metaldehyde 7.5G						yes	
Orthene TT&O	yes		yes	yes		yes	
Pinpoint 15G	yes		yes				
Scimitar GC, Demand CS	yes	yes	yes	yes	yes	yes	
Sevin SL, 80WP, XLR Plus	yes	yes	yes	yes	yes	yes	yes
Talstar	yes	yes	yes	yes	yes	yes	yes
Tempo SC ultra, Ultra WP, & 20WP GC	yes	yes	yes	yes	yes	yes	yes
Varsity Fire Ant Bait			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. NOTE: Products containing chlorothalonil, iprodione and vinclozolin are no longer labeled for use on home lawns.

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
<p>Algae (various species; primarily blue-green algae or cyanobacteria)</p> <p>All grasses</p> <p>Most prevalent on putting greens & other turf mowed excessively low.</p>	<p>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.</p>	<p>Improve air circulation and light exposure.</p> <p>Improve drainage and reduce irrigation frequency and amount.</p> <p>Reduce freely available nitrogen at site. On putting greens, verticut lightly, aerify, and/or topdress to disrupt and dry algal mats. Best results are with 5 gal water per 1,000 sq. ft. applied for 3 consecutive weeks when air temps. are at least 85 F.</p>	<p>chlorothalonil 54%F</p> <p>chlorothalonil 38.54% F</p> <p>chlorothalonil 82.5%WDG, DF</p> <p>chlorothalonil + thiophanate methyl 90WDG</p> <p>mancozeb 80WP</p> <p>mancozeb 75DF</p> <p>mancozeb 37%F</p> <p>mancozeb (15%) + copper hydroxide(46%)</p> <p>copper hydroxide 53.8%</p> <p>maneb (37%) + zinc F</p>	<p>2-3.6 fl oz</p> <p>2-3.6 fl oz</p> <p>4-5.5 fl oz</p> <p>2.9-5.1 fl oz</p> <p>2.9-5.1 fl oz</p> <p>5.8-7.9 fl oz</p> <p>1.8-3.2 oz</p> <p>1.8-3.2 oz</p> <p>3.6-5 oz</p> <p>2-5.76</p> <p>6 oz</p> <p>6 oz</p> <p>9.6 fl oz</p> <p>4-8 oz</p> <p>16 oz in 5 gal water</p> <p>9.6 fl oz</p>	<p>7-14 preventive</p> <p>7-14 curative</p> <p>14 curative</p> <p>7-14 preventive</p> <p>7-14 curative</p> <p>14 curative</p> <p>7-14 preventive</p> <p>7-14 curative</p> <p>14 curative</p> <p>7-14</p> <p>7-14</p> <p>7</p> <p>7-14</p> <p>7-14</p> <p>variable</p> <p>7-14</p>
<p><i>note:</i> chlorothalonil formulations have maximum use rates in effect that depends on site - see new labels for details.</p> <p><i>note:</i> fungicides are most effective when used preventative. Fungicides containing copper hydroxide may be phytotoxic; read label carefully and use precautions.</p>					

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
<p>Anthracnose leaf blight and Anthracnose basal rot (<i>Colletotrichum graminicola</i>)</p> <p>All grasses</p>	<p>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 dark, cushion-like reproductive structures (acervuli) with black spines (setae) extending from the margin of the cushion. Plants with anthracnose basal rot may have deep-seated infections that are not readily diagnosed with only a hand lens.</p>	<p>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.</p>	<p>azoxystrobin 50WDG chlorothalonil 38.5%F</p> <p>chlorothalonil 54% F</p> <p>chlorothalonil 82.5% WDG</p> <p>fenarimol AS trifloxystrobin 50WDG polyoxin 2.5 WP propiconazole 14.3% myclobutanil 40%WSP triadimefon 50 WSP chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG mancozeb + thiophanate methyl pyraclostrobin 20 WDG thiophanate methyl 50WSB thiophanate methyl 46%F thiophanate-methyl 41%F thiophanate methyl 50WP</p> <p><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, fenarimiol, triadimefon or myclobutanil at high rates in high heat conditions as unacceptable growth regulation may occur.</p>	<p>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 4.0 1-2 fl oz 0.6 1.0 oz 2-8 oz 3.72-5.76 3 oz 0.5-0.9 oz 1-2 oz 1-2 fl oz 2-8 fl oz 2-8 oz</p>	<p>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 7-14 14-28 14-21 30 7-14 7-14 5-14 14-28 10-14 10-14 7-14 7-14</p>

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
<p>Brown Patch, Rhizoctonia Blight (<i>Rhizoctonia solani</i>)</p> <p>bluegrass creeping bentgrass fescues ryegrass</p>	<p>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.</p> <p><i>note:</i> chlorothalonil formulations have new maximum use rates that depend on site - see new labels for details</p> <p><i>note:</i> Fungicides containing copper hydroxide may be phytotoxic; read label carefully & use precautions.</p>	<p>Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch.</p>	<p>azoxystrobin 50% WG chloroneb 65WP chlorothalonil 54.0%F</p> <p>chlorothalonil 38.5%F</p> <p>chlorothalonil 82.5% WG</p> <p>chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG fenarimol 11.6% AS fludioxonil 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% polyoxin 2.5 WP PCNB 75%WP PCNB 10%G PCNB 15%G PCNB 40F propiconazole 14.3% pyraclostrobin 20 WDG 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%)</p>	<p>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 2-8 oz 3.72-5.76 1.5 fl oz 0.25 -0.5 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 4 oz 3-4 oz 2-2.5 lb 1.5-2 lb 4.5-6 fl oz 1-2 fl oz 0.5-0.9 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 4-8 oz</p>	<p>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 7-14 7-14 14-21 14-21 14-21 14-28 14-28 7 7 7 7-14 14 7-14 7-10 7-10 7-10 7-10 14-21 14-28 5-14 5-14 7-14 7-14 7-10 15-30 14-28 7-14</p>
<p>Bentgrass Dead Spot (<i>Ophiosphaerella agrostis</i>)</p> <p>Creeping bentgrass Bermudagrass</p>	<p>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.</p>	<p>Encourage turf recovery with acidifying fertilizers. If spots are few, plug out and replace with healthy turf.</p>	<p>boscalid 70WDG fludioxonil 50% WP pyraclostrobin 20 WDG thiophanate methyl 41%F thiophanate methyl 50WP chlorothalonil + thiophanate methyl 90WDG</p>	<p>0.18 oz 0.3-0.5 oz 0.5-0.9 oz 4-8 fl oz 4-8 oz 3.72-5.76</p>	<p>14 14 14-28 7-14 7-14 7-14</p>

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
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.		
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. <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.	Avoid N deficiency. Irrigate in morning. Avoid thatch buildup. Wipe heavy dew off in mornings.	boscalid 70WDG chlorothalonil 54.0%F chlorothalonil 38.5%F chlorothalonil 82.5% WG chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG myclobutanil 40WSP propiconazole 14.3% pyraclostrobin 20WDG 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	0.13-0.18 oz 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 2-8 2-5.76 0.5-1.2 oz 0.5-2 fl oz 0.9 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	14-28 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 7-21 7-14 14-28 7-28 14 (suppression only) 10-28 14-28 14-28 7-14 7-14 7-14 28 28 28 14 7-14 10-14 7-14 7-14

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
			thiram 75WDG vinclozolin 50WP or DF mancozeb (15%) + copper hydroxide(46%)	2.5-5 oz 2 oz 4-8 oz	7-10 14-28 7-14
Fairy Ring (<i>Agrocybe</i> , <i>Chlorophyllum</i> , <i>Lycoperdon</i> , <i>Marasmius</i> , <i>Tricholoma</i> spp., and other mushroom fungi).	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., & <i>Bovista</i> sp.) flutolanil 50WP flutolanil 70WP flutolanil + thiophanate methyl 80WDG pyraclostrobin 20WDG	0.4 oz 6 oz 2.2-4.5 oz 3-6.12 0.9 oz	28 30 21-30 21-28 28
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. <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.	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 chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG fenarimol 11.6%AS fludioxonil 50%WP iprodione 23.3%F iprodione 50WP mancozeb 75DF mancozeb 80WP mancozeb 37%F maneb (37%) + zinc F mancozeb (15%) + copper hydroxide(46%) polyoxin 2.5 WP PCNB 75%WP PCNB 10G PCNB 15G PCNB 40F propiconazole 14.3% pyraclostrobin 20WDG triadimefon 50WSP thiophanate methyl 46%F thiophanate methyl 50WSB thiophanate methyl 50WP thiophanate methyl 41%F trifloxystrobin 50WG vinclozolin 50WP or DF	0.2-0.4 5.5 fl oz 7.9 fl oz 5 oz 6-8 oz 3.72-5.76 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 4-8 oz 4 oz 8 oz 3-5 lb 2-3.3 lb 3 fl oz 2-4 oz 0.5-0.9 oz 1-2 oz 1-2 fl oz 2 oz 2-4 oz 2-4 fl oz 0.2-0.25 2-4 oz	14-28 21-28 pre-disease 21-28 pre-disease 21-28 pre-disease Single application 7-14 1-2 applications late fall before snow 14-21 14-21 2-6 wk 14-42 14-42 14-42 7-14 7-14 4-6 wk 4-6 wk 4-6 wk 14 Single application 14-28 5-14 5-14 7-14 7-14 fall/early spring 10-21 14-42

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
<p>Gray Leaf Spot (<i>Pyricularia grisea</i>)</p> <p>bahiagrass bermudagrass centipedegrass ryegrass St. Augustinegrass tall fescue</p>	<p>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.</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>Avoid excess N. Irrigate deeply in early morning. Reduce traffic. Mostly a problem on recently planted or atrazine-treated St. Augustinegrass.</p>	<p>azoxystrobin 50WG * no more than 2 sequential sprays chlorothalonil 54%F</p> <p>chlorothalonil 38.5%F</p> <p>chlorothalonil 82.5%WDG</p> <p>chlorothalonil + fenarimol chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG mancozeb 80WP mancozeb 75DF mancozeb 37%F mancozeb + thiophanate methyl trifloxystrobin 50WDG polyoxin 2.5 WP propiconazole 14.3% pyraclostrobin 20WDG thiophanate methyl 50WSB thiophanate methyl 41%F thiophanate methyl 50WP triadimefon 50WSP</p>	<p>0.2-0.4 oz</p> <p>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 3 oz 2-8 3.72-5.76 8 oz 8 oz 12.8 fl oz 3-9 fl oz 0.15-0.25 oz 4 oz 1-2 fl oz 0.5-0.9 oz 4-8 oz 4-8 fl oz 4-8 oz 0.5-1 oz</p>	<p>14-28</p> <p>7-10 pre-disease 14 post-disease 7-10 pre-disease 14 post-disease 7-10 pre-disease 14 post-disease 7-10 7-14 7-14 14 14 14 7-14 14-21 7-14 14 14-28 10-14 7-14 7-14 14</p>
<p>"Helmintho- sporium" Leaf Spot (<i>Bipolaris, Drechslera</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. 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><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>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>chlorothalonil + thiophanate methyl 67WDG chlorothalonil + thiophanate methyl 90WDG fludioxonil 50%WP iprodione 50WP iprodione 23.3%F mancozeb + thiophanate methyl mancozeb 80WP mancozeb 75DF mancozeb 37%F mancozeb (15%) + copper hydroxide(46%) maneb (37%)+ zinc F myclobutanil 40WDG PCNB 75WP</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 2-8 2-5.76 0.25-0.5 oz 1.50-2 oz 3-4 fl oz 3 4 4 oz 6.4 fl oz 4-8 oz 4.8-6.4 fl oz 0.6 oz 7-10</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 7-14 7-14 14-21 14-28 14-28 5-14 7-14 7-14 7-14 7-14 7-14 14 21-28</p>

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
			PCNB 10G PCNB 15G PCNB 40F polyoxin 2.5 WP propiconazole 14.3% pyraclostrobin 20WDG trifloxystrobin 50WDG thiophanate methyl 50WP thiophanate methyl 41%F vinclozolin 50WP or DF	5-7.5 lb 3.3-5 lb 10.5-15 fl oz 4 oz 1-2 fl oz 0.5-0.9 oz 0.1-0.25 oz 4-8 oz 4-8 fl oz 1-2 oz	21-28 21-28 single application 7-14 14 14-28 14-28 7-14 7-14 12-28
<p>Large Patch (brown patch in warm season grasses; Zoysia patch, large patch of zoysia) (<i>Rhizoctonia solani</i> AG 2, 2 LP)</p> <p>zoysiagrass bermudagrass St. Augustinegrass centipede grass</p>	<p>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.</p>	<p>Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch. Correct compaction and areas of poor drainage.</p>	azoxystrobin 50WDG chloroneb 65 WP flutolanil 50WP flutolanil 70WP triadimefon 50%WSP iprodione 23.3% F iprodione 50WP myclobutanil 40WDG polyoxin 2.5 WSP 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 4 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 30 30 First application in early fall, follow in spring if necessary. First application in fall, repeat in spring. 14-21 Apply in fall before dormancy 7-14 28 28 28 28 One application in early fall, prior to symptoms. 7 to 14 7 to 14
<p>Powdery Mildew (<i>Blumeria graminis</i>)</p> <p>Most grasses; Kentucky bluegrass especially susceptible.</p>	<p>White, powdery like growth on the upper and lower leaf surfaces of grasses. The disease is most common in excessively shaded areas with high humidities.</p>	<p>Improve sunlight penetration and air movement or landscape the area with non-turfgrass plants that are shade tolerant.</p>	azoxystrobin 50WDG fenarimol AS myclobutanil 40WDG propiconazole 14.3% triadimefon 50WP	0.2-0.4 2-4 fl oz. 0.6 oz 1-2 fl oz 1-2 oz	14-28 Single application. 14-28 14-28 15-30

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
Pythium Blight (<i>Pythium</i> spp.) All grasses	Grass dies in spots or streaks. Initially, the affected grass has a dark color and a greasy appearance, particularly in spots. Spots may develop a copper color and eventually a bleached, straw color as affected tissues die and dry. After prolonged moist or foggy periods, the cottony mycelium may be seen on the turf (note: this symptom is NOT always evident). Pythium can be spread by foot traffic or mowers passing over infected grasses. Occurs during warm, humid, foggy weather in poorly drained soils. Ryegrass, rough bluegrass, and bentgrass used for overseeding are most susceptible.	Improve aeration and drainage. Avoid frequent, shallow irrigation. Reduce mowings and minimize equipment or foot traffic across infected turf. Wash equipment that passes from infected to non-infected grass areas.	azoxystrobin 50WG * no more than 2 sequential sprays	0.4 oz	10-14
			chloroneb 65WP ethazole 30WP ethazole 35WP fosetyl AI 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 pyraclostrobin 20 WDG propamocarb 66.5L phosphorous acid salts	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 0.5-0.9 oz 1.3-4 5-10	5-7 5-10 5-10 14-21 10-21 10-21 10-21 5 5 5 7-21 5 5 14-28 7-21 7-14
<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 & use precautions.					
Pythium Root Rot (<i>Pythium</i> spp.) 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 AI 80WDG	0.4 4-8 oz	10-14 14-21
			chloroneb 65WP ethazole 30WP phosphorous acid salts	4 2-5 5-10	5-7 7-14 7-14
Water into the root-zone. Only azoxystrobin, ethazole, fosetyl AI formulations have Pythium Root Rot on the label. <i>To minimize the potential for resistance, alternate between classes of fungicides.</i>					
Rapid Blight (<i>Labyrinthula terrestris</i>)	Patches from a few inches up to a foot in diameter occur most commonly in salinity-stressed cool season grasses. Affected turf can be chlorotic and water-soaked. Individual leaves appear blotchy.	Manage salinity by core aeration, gypsum applications and leaching regime	mancozeb 80WP pyraclostrobin 20 WDG trifloxystrobin 50 WDG	8 oz 0.5-0.9 oz 0.15-.25 oz	14 14-28 14-21
Red Thread (<i>Laetisaria fuciformis</i>) fescues and ryegrasses	The organism does not form a mycelium. 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	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	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

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
			fenarimol AS flutolanil 50WP flutolanil 70WP iprodione 50WP iprodione 23.3%F mancozeb 80WP mancozeb 75DF mancozeb 37%F mancozeb (15%) + copper hydroxide(46%) maneb (37%) + zinc F myclobutanil 40%WSP polyoxin 2.5 WSP propiconazole 14.3% pyraclostrobin 20WDG trifloxystrobin 50WDG thiophanate methyl 50WSB thiophanate methyl 50WP thiophanate methyl 41%F triadimefon 50WSP vinclozolin 50WP or DF	> 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 4 oz 2 fl oz 0.5-0.9 oz 0.1-0.25 oz 2 oz 2-4 oz 2-4 fl oz 0.5-1 oz 1-2 oz	14 post-disease 14 post-disease 30. 21-28 21-28 14 14 7-14 7-14 7-14 7-14 7-14 14-21 7-14 14-21 14-28 14-21 5-14 7-14 7-14 15-30 14-28
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. <i>note:</i> chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details.	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 pyraclostrobin 20 WDG	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 0.5-0.9 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 14-28
Southern Blight <i>(Sclerotium rolfsii)</i> Creeping bentgrass, bluegrasses, fescues, and ryegrasses	Yellow, circular or crescent shaped patches up to 1 ft in diameter, sometimes with “frog-eye” symptoms or less affected grass in the center of patches. Affected turf is a reddish-brown or bronze coloration, turning brown as it dies. Off-white or tan fungi sclerotia may be visible in the mat or thatch with a hand lens.	Avoid drought conditions preceding hot, humid or wet weather; improve poorly drained soils and improve aeration to roots and crowns.	azoxystrobin 50WDG chloroneb 65WP flutolanil 50WP	0.2-0.4 oz 4 oz 2 oz	14-28 5-7 21

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
			flutolanil 70WP triadimefon 50WSP	1.5 oz 0.5-2 oz	21 14-28
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. <i>note:</i> scout and map diseased spots in spring, treat with fungicides in late summer through early fall.	In established bermudagrass, thorough cultivation of dead areas may provide temporary recovery. Manage thatch by cultural methods, and avoid excess, unbalanced N fertilization in late summer or early fall.	azoxystrobin 50WDG fenarimol 11.6%AS myclobutanil 40%WSP propiconazole 14.3% thiophanate methyl 41%F thiophanate methyl 50WP	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 in 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</i> sp., and <i>Fuligo</i> sp.) All grasses	Bluish-gray encrustations on leaf blades. In spring and summer during heavy rain, prominent white or yellow slimy masses may develop. Slime molds are not parasites of turf.	Brush off or wash off 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 & Fall via label. 7-14 7-14 14-21 14
Bermudagrass Decline (<i>Gaeumannomyces graminis</i> var. <i>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.

Disease & Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹	Formulation Rate, (oz/1000 ft ²)	Application Interval (Days)
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% pyraclostrobin 20WDG thiophanate methyl 41% F thiophanate methyl 50WP triadimefon 50% WSP	0.4 oz 4-8 fl oz 2-4 fl oz 0.9 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. 2 applications, 28 days apart in spring & fall When disease symptoms appear, 7-14 day interval. 21-28 Early fall & early spring.
Rhizoctonia Leaf and Sheath Spot (<i>R. oryzae, R. zeae</i>) bermudagrass centipede grass creeping bentgrass St. Augustine grass 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	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.
<p>note: chlorothalonil formulations have new maximum use rates in effect that depends on site - see new labels for details. Some other active ingredients may be useful for control but are not specifically labeled for this disease – thiophanate methyl and other fungicides in the benzimidazole class are ineffective.</p>					
Yellow Patch (Cool weather brown patch) (<i>Rhizoctonia cerealis</i>) bentgrass, rough bluegrass, perennial ryegrass, zoysiagrass	Common in cold weather under prolonged cloudy conditions on bentgrass greens or overseeded bermudagrass greens. Yellow to orange irregular rings, with few leafspots in cool season grasses. Also in zoysia in early fall, causing leafspot symptoms in a ring-shaped pattern.	Improve drainage, manage thatch accumulations	azoxystrobin fludioxonil 50% WP flutolanil 50WP flutolanil 70WP propiconazole 14.3% polyoxin 2.5 WP thiophanate methyl 41% F thiophanate methyl 50WP	0.4 0.5 oz 2 oz 1.5 oz 3-4 fl oz 4 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.
Yellow Tuft (downy mildew) (<i>Sclerophthora macrospora</i>) Creeping bentgrass, St. Augustine grass	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. Augustine grass, 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% phosphorous acid salts	4-8 oz 0.5-1 fl oz 5-10	14-21 10-21 7-14

Trade Names for Common Turf Fungicides

Common Name	Trade Name ¹
azoxystrobin	Heritage
boscalid	Emerald
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
fludioxonil	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
polyoxin D	Endorse
propiconazole ³	Banner MAXX, Alamo
phosphorous acid salts	Alude, Magellan, Biophos, Resyst, Vital
propamocarb	Banol
pyraclostrobin	Insignia
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 + 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	Stripe Smut	Summer Patch	Take-all Patch	Yellow Patch (Cool Weather Brown Patch)	Yellow Tuft (Downy Mildew)
Aliette, Signature												
Banner Maxx												
Banol												
Bayleton												
Chipco 26019												
Cleary 3336												
Compass												
Curalan												
Daconil												
Eagle												
Endorse												
Fore												
Insignia												
Heritage												
Koban/Terrazole												
Medallion												
PCNB												
Phosphorous acids												
Prostar												
Rubigan												
Sentinel												
Spotrete												
Subdue Maxx												
Terraneb												

Turfgrass fungicides classified by chemical fungicide group.

Chemical Group (activity)	Common Name	Trade Name Examples
Anilide (Upward Mobile; Curative and Protective)	boscalid	Emerald
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
Carbamates (Upward Mobile; Curative and Protective)	Propamocarb Hydrochloride	Banol
Demethylation Inhibitors (DMI) (Upward Mobile; Curative and Protective)	Fenarimol Myclobutanil Propiconazole Triadimefon	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 200FL, Protect Manex, security Maneb Spray, Dithane -22 Special Spotrete 75, Spotrete-F, Thiramed
Phosphonates (Systemic; Curative and Protective)	Fosetyl-Al phosphorous acid salts	Aliette, Chipco Signature, Prodigy Alude, Magellan, Biophos, Resyst, Vital
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 SC, particularly in sandy native soils of the Sandhills and coastal regions, but also in artificial, sand-based rootzone mixes on putting greens or athletic fields. Depending on the species of nematode and the numbers in soil, they are capable of contributing heavily to the decline of turf. However, many times weak turf is blamed on nematodes when poor cultural practices, fungi, insects, nutrient problems, soil compaction, poor drainage, or other environmental problems may be the more serious factor leading to the decline. All of these other stresses can also make nematode damage worse. Therefore, correct diagnosis is important to adequately address the problem and determine if the use of a nematicide is warranted. Nematicides 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.

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.

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

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 bentgrass 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.

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

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

Nematicides for commercial turfgrass use.

Nematicide	Rate	Comments
Nemacur 10%; Turf & Ornamental Nematicide (fenamiphos 10%)	2.3 lb/1000 sq.ft. or 100 lb/A	Golf courses, cemeteries, industrial grounds; DO NOT USE on residential lawns or public recreational areas other than golf courses; not for use on turf being grown for sale or other commercial use as sod, or for commercial seed production, or for research purposes. Irrigate immediately with at least ½ inch of water; do not allow puddling or run-off to occur. Do not treat newly-seeded areas until plants have developed secondary root systems. Restricted Use Pesticide. See product label for further application restrictions. Not to exceed 200 lbs/acre/year.
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.
Curfew EC (1,3-dichloro-propene 97.5%)	3-5 gal/acre broadcast basis	Special local need label. For golf course use only, by certified commercial applicators. Do not re-enter treated areas for 24 hours. Do not apply within 100 feet of any occupied structure, such as a school, hospital, business or residence. Curfew should be placed a minimum of 5 inches deep, with soil moisture adequate to provide good turfgrass growth, and such moisture content maintained for 7 days post-application. Immediately after application, apply ¼ to ½ inch of irrigation.

¹The 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
Curfew EC	yes	yes	yes	no	no	no	no	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	—	—	—	T
Bromacil	Acti-Cil, Hyvar, Opti-Kill,	—	T	T	—
Bromacil + diuron	Krovar	—	T	T	—
Dazomet	Basamid	T	—	—	—
Diquat	Reward, Aquatrim II	—	—	—	T
Glufosinate-ammonium	Finale, Derringer	—	—	T	T
Glyphosate	Gly-Flo, Prosecutor, Razor, Roundup Pro & Pro Dry, Trailblazer, Touchdown Pro	—	—	T	—
Glyphosate + diquat dibromide	QuickPRO, Prosecutor Swift Acting			T	T
Imazapyr	Arsenal	—	T	T	—
Imazapyr + diuron	Sahara	—	T	T	—
Metam sodium	Metam CLR, Vapam HL, Soil Prep	T	—	—	—
Methyl bromide	MB 98, MBC, Dowfume MC-2, Brom-o-gas, Profume, Terr-o-gas	T	—	—	—
Pelargonic acid	Quik, Scythe	—	—	—	T
Prometon	Pramitol, Spot	—	T	—	—
Prometon + 2,4-D	Vegemec	—	T	T	T
Tebuthiuron	Spike	—	T	—	—

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

COMMON NAME	TRADE NAME (rate)	WEEDS CONTROLLED	COMMENTS
Methyl bromide	Dowfume MC-2 Brom-o-gas Profume Terr-o-gas (1 to 2 lb/100 ft ²)	Non-selective, including bermudagrass, nutsedge, and soil pathogens & nematodes	Methyl bromide is formulated as liquid gas under pressure that forms a vapor when released. One to 1½ lb material is used per 100 sq.ft. treated soils. Use the higher rate when soils are heavy in texture, wet, or soil temperatures are below 60 F. Fumigation will not be effective if soil temperature is below 50 F. Soil should be moist but not saturated when treated. Before use, the soil should be in a condition suitable for planting including seedbed preparation by plowing soil 8 to 10 inches in depth, free of clods and undecomposed organic matter, then releasing the chemical under a gasproof (plastic) cover with the edges sealed and leaving it for 24 to 48 hours. Control will be only as deep as the soil is adequately tilled. Most other soil pests are also controlled. Grass can be planted 2 to 3 days after cover removal but do not disturb soil below 2 inches when planting. Unclassified herbicide family. Methyl bromide is a toxic material used by professional applicators only, slated to be phased out starting Jan. 1, 2005. Some methyl bromide formulations are Restricted Use Pesticides. Hiring a contractor who specializes in fumigation is recommended for those unfamiliar with the process. Chloropicrin is added as 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) Vapam HL 42% (30 to 75 gal/A) Sectagon	Non-selective	Both products must first decompose to the biocidal ingredient, methyl isothiocyanate, thus, inconsistent pest control often results as temperature, plant residue, and soil moisture affect this conversion. A plastic or polyethylene cover is not required but increased control usually results with one. When a cover is not used a water soil-seal method should be followed. Cultivate the soil to the desired depth of fumigant penetration. Soil temperatures should be above 50F before use. Moisten the soil and use 1 to 2 pints of metham product per 100 sq.ft. in 2 to 5 gallons of water or 8 to 10 oz of Dazomet per 100 sq.ft. of prepared soil surface. The soil should then immediately be incorporated with a rotary tiller 4 to 8 inches deep and sealed with water at 15 gals. per 100 sq.ft. Light rolling will improve soil/water seal. If a cover is available, treat the soil in front of a rotary tiller. Cover the soil for 2 days. Planting may take place 2 to 3 weeks after treatment. Aeration may be required by rototilling before planting. Metham is a dithiocarbamate herbicide member. Read and follow all label directions. Metham is a restricted-use-pesticide while Dazomet is not. Control of legumes, sedges from seed, and morningglories with dazomet may be erratic.
Dazomet	Basamid 99 Granular (255 to 450 lb/A)		

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

COMMON NAME	TRADE NAME (rate)	WEEDS CONTROLLED	COMMENTS
glyphosate (4 lbs ai/A)	Roundup Pro/4S (1 gal/A)	Torpedograss, bermudagrass, nutsedges, other perennial weeds.	These are applied only to unwanted vegetation and will not control non-germinated seeds, diseases, nematodes, or other pests. Used also for edging and trimming. Use 4 to 5 quarts per acre glyphosate (4 lb/gal) for broadcast bermudagrass control. Apply to actively growing green vegetation that is at least 4 to 5 inches tall. Wait 2 to 3 weeks after application for regrowth and re-apply. A minimum of 3 applications will be required to control bermudagrass or torpedograss. Fusilade II at 24 oz/a can be mixed with glyphosate (4 lb/gal) at 2 qts/a and applied twice for comparable control of bermudagrass (~95%) to 3 applications of glyphosate alone. However, 14 days should lapse between the last treatment and seeding. For spot treatment, Glyphosate (4 lb/gal) is applied at 2 oz. per gallon of water; Reward 2EC is used at 4 teaspoons (¾ fl oz) + 1 teaspoon of nonionic surfactant per gallon of water, QuickPRO is used at 1.5 oz per gallon while Finale 1SC is used at 1½ to 4 fl oz per gallon of water without additional surfactant. Do not apply to desirable plants. Glyphosate and glufosinate are Amino Acid Dervative herbicide family members while diquat is a bipyridyllum.
glyphosate + diquat (3.55 to 6.7 lbs)	QuickPRO 76 WG (4.5 to 9 lb/a)	Non-selective.	
glufosinate (¾ to 1½ lbs ai/A)	Finale 1SC (¾ to 1½ gal/A)		
diquat (1 lb ai/A)	Reward 2EC (½ gal/A)		

PREEMERGENCE 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.

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

Herbicide (trade name)	Crabgrass	Goosegrass	Annual bluegrass	Common Chickweed	Herbit	Lawn Burweed	Speedwell spp.	Spurges	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
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
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
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.

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.

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	--		--
Devrinol	napronamide	--		--
Betasan	bensulide			
Kerb	pronamide	--		
Rubigan	fenarimol	--		
Tupersan	siduron		--	--

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

COMMON NAME (lbs ai/acre) ²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
oxadiazon (2 to 4 lbs)	Ronstar 2G (100 to 200 lbs) Ronstar 50W (4 to 6 lbs)	Pre-plant annual grasses, especially goosegrass	Post-planting bermudagrass and zoysiagrass sprigging	Safest preemergence herbicide on newly sprigged or high traffic areas. Apply to dry turf and irrigate immediately after application. Oxadiazole (or Triazolinone) herbicide.
metolachlor (1.8 to 3.9 lbs)	Pennant 7.8L (2 to 4 pts)	Pre-plant yellow nutsedge, annual sedge, sprangletop, some annual grasses	Pre-plant centipedegrass, St. Augustinegrass, and zoysiagrass sprigging	The higher rate will be necessary for turf grown on high organic (i.e., muck) soils. For commercial St. Augustinegrass sod production, do not use more than once every 6 weeks and do not apply more than 8 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Irrigate within 7 days after application. Acetanilide herbicide.
atrazine/simazine (1 to 2 lbs-sandy soil) (4 lbs-muck soil)	Atrazine Aatrex 4L (1-2 qts), 90DG (1.1-2.2 lbs), 80W (1.2-2.5 lbs); Purge Simazine Princep 90DF, 4L + others	Pre-plant for many broadleaf weeds and suppression of crabgrass	Pre-plant centipedegrass seeding and pre- plant St. Augustinegrass, centipedegrass, & zoysiagrass sprigging/sodding	Apply to centipedegrass, St. Augustinegrass, 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. Do not apply within the root zone of ornamentals nor within 4 months of overseeding. Atrazine is a Restricted Use Pesticide. Triazine herbicides.
quinclorac (0.75 lb)	Drive 75 DF (1 lb)	Pre-plant crabgrass, signalgrass, barnyardgrass, foxtail, selective broadleaf weeds such as pennywort, speedwells, dandelion, black medic, white clover, violets	Pre-plant seeding of annual bluegrass, ryegrass, bentgrass fairways, common bermuda, Kentucky bluegrass, tall fescue, zoysiagrass	Good soil moisture should be present before treatment. Creeping bentgrass, hybrid bermudagrass, & fine fescue have intermediate tolerance. Do not apply to desirable bahiagrass, centipedegrass, St. Augustinegrass, or dichondra. Tank mixing with N or Fe may lessen turf discoloration. Add a crop oil concentrate (2 pts/a) or methylated seed oil (1.5 pts/a) to increase performance. Not labeled for golf greens or collars. Avoid drift onto ornamentals. Quinolinecarboxylic Acid herbicide.
siduron (8 to 12 lbs)	Tupersan 50WP (16 to 24 lbs)	Pre-plant crabgrass control	Pre-seeding cool- season turfgrasses	Provides ~30 days preemergence control of crabgrass in newly seeded Ky. bluegrass or fescue (red or tall) areas. Do not use on warm-season grasses. At least ½-inch of water is needed within 3 days of application for preemergence activity. Substituted urea herbicide.

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

COMMON NAME (lbs ai/acre) ²	TRADE NAME EXAMPLES (rate of product/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
benefin (2 to 3 lbs)	Balan 2.5G (80 to 120 lbs) 2.5 Benfin G (80 to 120 lbs) Balan 1.5EC (1 to 2 gal)	Summer annual grasses, annual bluegrass, some selected annual broadleaves.	Established Bahiagrass Bermudagrass Centipedegrass Kentucky bluegrass Red fescue St. Augustinegrass Tall fescue Zoysiagrass	Apply only to well-established turf before annual weed seed germination. Due to short residual life, for continued weed control, a second application 60 to 75 days after the initial is required. For annual bluegrass control, use full rate in September. Wait to reseed or overseed with ryegrass 6 weeks following the low herbicidal rate and 12 to 16 weeks after for the high herbicidal rate. Minimum 3 month waiting period is required before sprigging or sodding. Read the label for irrigation requirements to activate the herbicide. DO NOT APPLY TO IMMATURE TURF , desirable overseeding, or on golf greens. Dinitroaniline herbicide.
benefin (¾ -1 lbs) + trifluralin (¾ -1 lb)	Team 2G (100 to 150 lbs) Team Pro 0.86 G (175 to 350 lbs)			Same as for benefin. For use by professional applicators only. Good for use in mixed stands containing cool and warm-season turfgrasses. Wait to reseed or overseed with ryegrass 8 weeks following the low herbicidal rate and 12 to 16 weeks after for the high herbicidal rate. Team Pro is a dry fertilizer based material containing 0.43% benefin + 0.43% trifluralin. Dinitroaniline herbicides.
bensulide (7½ to 12½ lbs)	Betasan 3.6G (209-348 lbs) Pre-San, Lescosan 7G (107-180 lbs) Pre-San 12.5G (60-100 lbs) Bensumec, Lescosan 4E (1.9-3.1 gal) ProTurf Weedgrass Preventer 8.5G (88-147 lbs)			Same as for benefin. Use high rate in fall for annual bluegrass control. Safe on overseeded areas and golf greens. If used on putting greens, apply 4 months before overseeding. Sulfonamide herbicide.
dithiopyr (½ lbs)	Dimension 1E (½ gal) Dimension Ultra 40WSP (0.95 lbs) (each 5 oz water soluble bag contains 0.125 lb dithiopyr)	Same as for benefin, plus oxalis (woodsorrel)		Same as for benefin. Do not use within 3 months of seeding or sprigging. A total of 1½ lb ai/A is allowed yearly 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.

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
metolachlor (1.8 to 3.9 lbs)	Pennant 7.8L (1.8 to 4 pts) Pennant Magnum 7.62 L (1.9 to 4.1 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.
napropamide (2.0 lbs)	Devrinol 50WP (4.0 lbs) Devrinol 2G (100 lbs) Devrinol 5G (40 lbs)	Same as for benefin	Established Bahigrass 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) Pendulum AquaCap 3.8 CS (3.1 to 6.3 pts) Pendulum 3.3 EC (4.5-7.9 pts) 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. A total of 3.5 lbs ai/a is allowed yearly. Use low rate on golf greens. Spring application on overseeded, cool-season grasses may prematurely thin them. 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
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 a 32-3-12 dry fertilizer carrier and include a 0.5G and 0.37G formulation. Dinitroaniline herbicide.
atrazine/simazine (2.0 lbs-sandy soil) (4.0 lbs-muck soil)	Atrazine Aatrex 4L (1-2 qts), 90DG (1.1-2.2 lbs), 80W (1.2-2.5 lbs); Purge Simazine Princep 90DF, 4L Wynstar 90DF + others	Same as for benefin plus pennywort (dollarweed), henbit, chickweed, lawn burweed (or spurweed) and some annual sedges. Perennial broadleaf weeds such as wild garlic, dock & others usually escape.	Centipedegrass St. Augustinegrass Zoysiagrass Dormant Bermuda	Apply to centipedegrass, St. Augustinegrass, and zoysiagrass only. Use in dormant bermudagrass in early December plus February for winter weed control. Do not use on desirable cool-season grasses. Will provide good to excellent weed control with a minimum of growth retardation to newly sprigged, sodded, or plugged turf areas at rates not in excess of 1 lb ai/A. Effectiveness will be reduced as weeds mature. Two applications are allowed per year. 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. 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. Contains 5.25% bensulide + 1.31% oxadiazon. Apply only to dry turf and when temperatures are <80F. Irrigate-in immediately with ¼ to ½-inch water.

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
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 7 to 10 days prior to overseeding. Also used for non-selective control of annual bluegrass and ryegrass in non-overseeded bermudagrass. Treat in fall to early winter for best results. Sulfonylurea herbicide.
pronamide (½ to 1 lb)	Kerb T/O 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 (to 1 lbs)	Broadleaves such as chickweed, clover, henbit, bittercress, spurge, plantain, and others	Bahigrass Buffalograss Bentgrass Bermudagrass Centipedegrass Chewings Fescue Perennial Ryegrass St. Augustinegrass Tall Fescue Zoysiagrass	Control is best for annual broadleaf weeds. Tank mix with another preemergence 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: Best results occur when applications are made to young, actively growing weeds. Applications when air temperatures are 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	Bentgrass 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 (QuickSilver)	NR	S	S	S	S	S	S	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 Southern)	NR	S	S	S	S	S	S	S
chlorsulfuron (Corsair, TFC)	NR	I	NR	NR	I-S	S	NR	S
clopyralid (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 + dichlorprop (2,4-DP)	I	I	S	S	S	S	S	S
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 + clopyralid	S	S	S	S	S	S	S	NR
fluroxypyr (Spotlight)	NR	S	S	S	S	S	S	S
halosulfuron (Manage)	NR	I	S	S	S	S	NR	S
imazapic (Plateau)	NR	NR	NR	NR	NR	NR	NR	NR
imazaquin (Image)	NR	NR	NR	NR	NR	NR	S-NR	NR
metsulfuron (Manor)	NR	NR	NR	NR	I	I	S	NR
quinclorac (Drive)	NR	I	S	S	NR	S	S	NR
simazine (Princep T&O)	NR	NR	NR	NR	NR	NR	S	NR
sulfentrazone + 2,4-D + dicamba + MCP (Surge)	NR	S	S	S	S	S	S	NR
triclopyr (Turflon)	NR	NR	S	S	S	S	NR	NR
triclopyr + clopyralid (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	Centipede-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 (QuickSilver)	S	S	NR	S	I	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 Southern)	S	S	NR	S	S	S	NR	S
chlorsulfuron (Corsair, TFC)	I	S	I	I	I	I	NR	NR
clopyralid (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 + dichlorprop (2,4-DP)	S	S	I	I	I	S	S	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 + clopyralid	S	S	I	S	NR	S	NR	S
fluroxypyr (Spotlight)	S	S	S	S	S	S	S	S
halosulfuron (Manage)	S	S	S	S	S	S	S	S
imazapic (Plateau)	NR	S	NR	S	NR	NR	NR	NR
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
sulfentrazone + 2,4-D + dicamba + MCP (Surge)	S	S	S	S	S	S	S	S
triclopyr (Turflon)	NR	NR	NR	NR	NR	NR	NR	S
triclopyr + clopyralid (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	Bentgrass Greens	Bentgrass Fairways	Ryegrass	Tall Fescue	Fine Fescue	Kentucky bluegrass	Buffalograss	Seashore Paspalum	Kikuyu-grass
Grass Weed Control									
asulam (Asulox)	NR ¹	NR	NR	NR	NR	NR	I-NR	NR	NR
bispyribac-sodium (Velocity) ⁴	NR	NR	S	NR	NR	NR	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
foramsulfuron (Revolver)	NR	NR	NR	NR	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
sulfosulfuron (Certainty)	NR	NR	NR	NR	NR	NR	S	NR	S
trifloxysulfuron (Monument)	NR	NR	NR	NR	NR	NR	NR	NR	NR
quinclorac (Drive)	NR	I	S	S	I	S	S	S-NR	NR

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

Herbicides	Bahia-grass	Bermuda-grass	Carpet-grass	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
bispyribac-sodium (Velocity) ³	NR	S ⁴	NR	NR	NR	NR	S ⁴
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) ³	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
foramsulfuron (Revolver)	NR	S	NR	NR	I	S	NR
metribuzin (Sencor Turf)	NR	S-I	NR	NR	NR	NR	NR
pronamide (Kerb)	S	S	NR	S	S	S	NR
rinsulfuron (TranXit)	NR	S	NR	NR	NR	NR	NR
sethoxydim (Vantage)	NR	NR	NR	S	NR	NR	NR
sulfosulfuron (Certainty)	I	S	NR	S-I	S-I	S	NR
trifloxysulfuron (Monument)	NR	S	NR	NR	NR	S	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. ³Used on dormant bermudagrass overseeded with perennial ryegrass.

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

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

Herbicide ¹	Crabgrass	Goosegrass	Annual Bluegrass	Sandspur	Dallisgrass	Thin (Bull) Paspalum	Ryegrass	Smutgrass	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	—
bispyribac-sodium (Velocity)	—	—	G	—	—	—	P	—	—	—	—	P	—
chlorsulfuron (Corsair, TFC)	P	P	P	P	P	P	G	F	P	P	G	P	—
clethodim (Envoy)	E	G-E	G	G	--	—	G-E	—	—	—	P	G	G
diclofop (Illoxan)	P	G-E	P	P	P	P	G	P	P	P	P	P	—
DSMA, MSMA	G	F	P	G	F	F-G	P	P	F	G	P	P	—
ethofumesate (Prograss)	P	P	F-G*	P	P	P	P	P	P	—	P	P-G	—
fenoxaprop (Acclaim)	G-E	G-E	P	G	P	P	P	P	G	—	P	F-G	—
fluzifop (Fusilade II)	G-E	G	F	G	P	P	G-E	P	G	—	P	G	G
foramsulfuron (Revolver)	P	G	E	—	F	--	E	--	--	--	E	P	--
imazapic (Plateau)	G	G	P	P	F	--	F	--	F	--	G	P	P
metribuzin (Sencor)	F-G	G-E	G	—	F	P	F	P	P	—	F	P	—
metsulfuron (Manor)	P	P	P	P	P	P	G	P	G	P	F	P	—
pronamide (Kerb)	P	P	G-E	P	P	P	G-E	P	P	—	G	P	F-G
rimsulfuron (TranXit)	P	P	G	P	P	P	G	P	P	P	P	P	P
sethoxydim (Vantage)	G-E	G	P	G	P-F	P	P	P	G	P	P	F-G	F-G
simazine (Princep T&O)	P-F	P	G-E	P-F	P	P	G-E	F	F	P	F	P-F	F
sulfosulfuron (Certainty)	P	P	G	—	P	P	P	--	P	P	--	P	G
trifloxysulfuron (Monument)	P	P	E	—	F	—	E	—	F	—	E	P	—
quinclorac (Drive)	E	P	P	—	F	P	P	P	P	P	P	P	—

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.

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

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	Chlorsulfuron	Clopyralid	Imazaquin	Imazapic	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Carfentrazone + 2,4-D + MCP + MCPA &/or dicamba	Quinclorac	Sulfentrazone + 2,4-D + MCP + dicamba	Fluroxypyr
Aster	P ¹	--	G	--	--	F	G	F	P	P	--	G	--	--	G	--	F	G	G	G	--	G	--
Bedstraw, smooth	P	--	P	P-F	G	F	F	G	--	--	G	--	--	G	P	F-G	G	G	G	G	--	G	E
Beggarticks	A	G	G	--	--	--	G	G	G	--	--	--	--	--	--	--	G	G	G	G	--	--	--
Betony, Florida	P	F-G ²	F	F	F-G	F	F-G	F-G	P	P	--	--	--	--	G	--	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	G	E	F-G	G
Burclover	A	--	F-P	E	E	E-F	E	E	--	--	F	G	--	--	G	G	--	--	--	G	--	F-G	--
Buttercups	WA,B&P	F	G	F	F-G	E	E	E	P	P	G	G	G	--	E	--	G	E	G	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	--	G	G
Carpetweed	SA	E	G	F	E	E	E	E	--	--	--	--	--	--	P	--	G	--	G	G	--	G	--
Carrot, wild	A,B	--	G	F	E	G	P-F	E	--	--	G	--	--	--	E	G	F	G	G	G	--	G	--
Catsear	P	--	E-F	F	E	E	E	E	--	--	--	--	--	--	--	--	G	E	E	--	--	--	--
Chamberbitter	SA,P	G-E	P	--	--	--	--	--	P	--	--	--	P	--	E	--	E	--	--	--	--	--	--
Chickweed, common	WA	E	P	G	G	E	E	E	F-G	P	G	--	G	--	E	--	E	E	E	G	--	G	G
Chickweed, mouse-ear	WA,P	F-G	G	G	G	E	E	E	P	P	G	P	G	--	E	P-F	E-F	E	E	G	--	G	G
Chicory	P	--	G	E	G	E	E	E	--	--	--	--	--	--	E	G	G	--	G	G	--	G	--
Cinquefoil, common	P	--	E-F	E-F	E-F	E-F	E-F	E-F	--	--	F	--	--	--	--	--	--	--	--	G	--	G	--
Clover, crimson	SA	--	G	G	G	E	E	E	--	--	G	G	--	--	--	--	E	E	G	E	E	G	--
Clover, hop	WA	E	F-G	G	G	E	E	E	--	F	G	G	--	--	F	--	E	E	E	G	E	G	--
Clover, white	P	E	F-G	G	G	E	E	E	--	--	G	G	G	--	E	F-G	E-F	E	E	G	E	G	G
Cudweed	WA	G-E	G-E	--	E	G-E	G-E	E	--	G	--	--	G	--	--	--	G-E	G-E	G	--	--	G	--
Daisy, English	P	--	P	F	G	G	F	E	P	P	--	F	--	--	--	--	--	G	G	G	F	F-G	--
Daisy, oxeye	P,B	--	F	F	F	F	F	E-F	--	--	--	--	F	--	--	--	--	--	--	--	--	G	--
Dandelion	P	E-F	G	G	G	E	E	E	P	P	G	F-G	P-F	--	E	G	F-E	G	G	G	F-G	G	F-G
Dayflower, Spreading	SA	G-E	F	F	F	F-G	F-G	F-G	G	--	--	--	G	--	G	--	F-G	--	--	G	P	G	--
Deadnettle, purple	WA	G-E	G	F	G	F	--	F-G	--	--	--	--	--	--	P	--	--	F	--	G	G	G	E
Dichondra	P	E-F	E	F	E-F	E	E	E	--	--	--	--	--	--	--	--	--	E	--	--	E	--	--
Dock, broadleaf & curly	P	F	G	F-G	F-G	G	F-G	E-F	P	P	G	G	--	G	G-E	F-G	G	E	E	G	--	G	--
Dogfennel	P	--	G	--	G	--	--	E	--	--	--	--	--	--	G	--	E	E	G	G	--	G	--

Weed	Lifecycle	Atrazine/ Simazine	2,4-D	MCPP	Dicamba	2,4-D + MCPP	2,4-D + 2,4-DP	2,4-D+MCPP+ dicamba	Benazon	Bromoxynil	Chlorsulfuron	Clopyralid	Imazaquin	Imazapic	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Carfentrazone + 2,4-D + MCPP + MCPA &/or dicamba	Quinclorac	Sulfentrazone + 2,4-D + MCPP + dicamba	Fluroxypyr
Doveweed	SA	G-E	F	F	F	F-G	F-G	F-G	P	P	--	--	--	--	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	--	G	--
Garlic, wild	P	P	G	P		E-F	E-F	E-F	P	P	F	--	G	G	G-E	--	G	--	--	G	P	G	--
Geranium, Carolina	WA	E	E	E-F	E	E	E	E	--	--	F	--	G	G	P-F	--	--	--	G	G	--	G	--
Groundsel	WA	--	G	G	--	G	G	G	G	G	G	G	--	--	E	--	G	--	--	G	--	G	--
Hawkweed	P	--	G	P	G	E-F	E-F	E-F	--	--	--	--	--	--	--	--	--	G	G	G	--	G	--
Healall	P	--	G	P	E-F	E	E	E	P	P	--	P	--	--	G	P	--	E	E	G	--	G	--
Henbit	WA	E	F-G	F	G-E	F	E-F	E	P	F-G	G	--	G	G	E-F	--	E	G	G	G	--	G	F-G
Horseweed	WA,SA	E	F	--	E	--	--	G-E	--	--	--	G	--	--	G	--	E	E	--	--	F-G	--	--
Ivy, ground	P	--	F-G	G	F-G	G	F-E	E-F	P	P	--	--	--	--	G	G	F	G	G	G	--	G	G
Knawel	WA	--	P	F	E	E-F	E-F	E	--	G	--	--	G	--	--	--	G	--	G	--	--	--	--
Knotweed, prostrate	SA	E	F	F	G	G	G	F-G	--	F	G	--	--	--	F	--	G	G	G	G	--	G	F-G
Kochia	SA	--	G	--	G	G	F	G	--	G	--	--	--	G	G	--	G	--	G	--	--	--	--
Lambsquarters	SA	G	G	G	G	F	F	G	G	G	G	--	--	G	G	G	G	F	G	G	--	G	--
Lespedeza	SA	E	F-P	E	E	E-F	F	E	--	--	--	G	--	--	E	G	G	E	E	G	--	G	--
Mallow	P	--	F-G	F	G	E-F	E-F	E-F	P	F	G	--	--	--	--	--	G	G	G	G	--	G	--
Medic, black	A	--	P	F	G	G	E	E	--	--	--	G	G	--	--	G	G	E	G	G	E	G	G
Moneywort	P	--	G	--	--	G	G	G	--	--	--	--	--	--	--	--	G	G	--	--	--	--	--
Mugwort	P	--	F	F-P	G-E	F	F	F	--	--	--	F-G	--	--	--	P-F	--	--	--	--	--	--	--
Mustard, wild	WA	E	G	F	G	E	E-F	E	G	G	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	--	G	--
Parsley-piert	WA	E	P	E-F	E-F	E-F	P	E-F	G	G	--	--	G	--	G-E	--	E	--	--	G	--	G	--
Pearlwort	WA	--	E-F	E-F	--	E-F	E-F	E-F	--	--	--	--	--	--	--	F	--	--	--	--	--	--	--
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	--	G	--
Pigweed	SA	G	G	G	G	E-	G	E	P	G	G	--	--	G	G-E	F-G	--	--	--	G	--	E	--
Pineapple-weed	WA,SA	--	F	F	--	F	F	F	--	--	G	G	--	--	G	--	F	--	--	G	--	G	--

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	Chlorsulfuron	Clopyralid	Imazaquin	Imazapic	Metsulfuron	Triclopyr	2,4-D + triclopyr	Triclopyr + clopyralid	MCPA + triclopyr + clopyralid	Carfentrazone + 2,4-D + MCP + MCPA &/or dicamba	Quinclorac	Sulfentrazone + 2,4-D + MCP + dicamba	Fluroxypyr
Plantains	P	F-P	G	G	G	E	E	E	P	P	F	G	--	G	G-F	F-G	F-G	E	E	G	--	G	F-G
Purslane, common	SA	G	G	F	G	G	G	E-F	G	--	G	--	--	G	G	G	--	--	G	G	--	G	E
Pusley, Florida	SA	--	G	--	G	--	F	G	--	--	--	G	--	G	G	--	G	--	G	G	--	G	--
Ragweed, common	SA	G	G	G	G	G	F	G	F	G	G	G	G	G	G	G	G	F	G	G	--	G	--
Rocket, yellow	WA,B	--	F-G	F-G	F	G	G	G	--	G	G	--	--	--	P	--	G	--	G	G	--	--	--
Shepherd's-purse	WA	--	G	E-F	G	E-F	E-F	E	G	G	G	F	--	--	G	--	--	G	G	G	--	G	--
Sida	A	--	--	--	--	--	--	F-G	G	--	--	--	--	G	--	--	--	G	--	--	--	--	--
Smartweed	SA	G	G	--	G	--	G	G	G	G	G	G	G	F-G	G	G	F-G	G	G	G	--	G	--
Sorrel, red	P	--	G	E	G	G	F	G	G	G	--	G	G	--	G	F-G	--	E	G	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	F-G	G	P	G	--	G	--	--	G-E	F-G	G	F-G	G	--	--	F-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	--	--	--	G	E	F-G	E-F	E-F	G	G	G	G	--
Spurge, spotted	SA	E	F-P	G	G	G	F	G	P	P	--	--	--	G	E	F-G	F	E-F	G	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-G	E	E	F-G	--	--	--	--	G-E	F-G	E	E	G	--	--	--	--
Strawberry, Indian mock	P	--	P	F	E-F	F	P	E-F	--	--	--	--	--	--	--	--	--	--	--	--	--	G	--
Thistles	B,P	P	G	G	G	E-F	E-F	E	G	G	F	G	G	F	P-F	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	--	F-G	--
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-G	P	P	G	F-P	F-P	F-P	P	P-F	--	P	--	G	E-F	F-G	--	E-F	--	G	--	--	--
Yarrow	P	--	F	F	E	G	G	E-F	P	P	G	--	--	--	F-G	F-G	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. Phenoxy herbicides.
2,4-D + 2,4-DP (0.7 to 0.9 each) See product label.	Weedone DPC (3 to 4 pts)			
dicamba (to ½ lbs) See product label.	Vanquish 4S (¼ to 1 pts) plus others	White clover, spurges, woodsorrel, dichondra, wild onions, henbit, knotweed, lespezeza, docks, + others		Avoid drift. Often effective on weeds not controlled by 2,4-D such as henbit, knotweed, clovers, lespezeza, docks, and woodsorrel, therefore, is used in many 2- and 3-way mixtures. Do not apply within the root zone of ornamentals as dicamba may leach and damage desirable plants. Repeat applications 10 to 14 days apart may be needed for complete control but may also result in some turf injury. Check label for use on greens; may be used on bentgrass tees & fairways. Use one-half rate on cool-season grasses. Benzoic acid herbicide.
dicamba (lbs) + 2,4-D, MCP, MCPA, 2,4-DP (½ to ¾ lbs) &/or clopyralid, triclopyr, fluroxypyr, carfentrazone, sulfentrazone	Several brands contain these mixtures. See product label for specific rates.	Same as for dicamba, also matchweed, clover, spurge, pennywort and others.		Same as for dicamba. Refer to product label for rates as herbicide ratios vary between brands. Use only on actively growing, non-stressed turf. Use low rates on cool-season grasses. Check label for use on golf greens. Mecomec 4 (¾ fl oz/1000 sq.ft.) and MCP-4 amine (¾ fl oz/1000 sq.ft.) are MCP 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 MCP + 2,4-D + dicamba formulations for greens, yellowing may occur.
carfentrazone (0.0022 to 0.031 lbs)	QuickSilver 1.9 EC (0.55 to 2.1 fl oz)	Broadleaf weeds such as chickweed, white clover, dandelion, spurge, corn speedwell and plantain		Weed control is best when applied to small actively growing weeds (1-4 inches in height). This product is a contact herbicide with little to no residual activity. Can be used on centipedegrass and St. Augustinegrass (use low rate). For more advanced weeds and broader weed spectrum, this product can be tank mixed with 2,4-D, dichloprop, dicamba, MCP, MCPA and atrazine. Use rates less than 1 fl oz/a when in combination with other herbicides. Maximum rate is 2.1 fl oz/a and a maximum of 3 broadcast applications per year per application site. Do not apply to hybrid bermudagrass or carpetgrass.
clopyralid (0.09 to 0.5 lbs)	Lontrel T&O 3L (¼ to 1 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. Aster and legumes are especially susceptible. Not labeled for golf greens or tees or for residential turf.
clopyralid + triclopyr (0.09-0.19 + 0.28-0.56)	Confront 3L (1 to 2 pts)			Do not use treated clippings for mulching and compost. 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.

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
fluroxypyr (0.125 to 0.5 lbs)	Spotlight 1.5L (to 2 pts)	Broadleaf weeds such as white/hop clover, ground ivy, chickweed, henbit, dandelion, plantain, purple deadnettle, woodsorrel, annual lespedeza and other broadleaf weeds		Weed control spectrum increases when tank-mixed with 2,4-D, MCP, triclopyr, &/or dicamba. Maximum use rate of 1.33 pints/acre on bentgrass, St. Augustinegrass, zoysiagrass and centipedegrass and a total of 2 pints per acre per growing season. Safe on most warm- and cool-season turfgrasses. Not labeled for golf greens or tees. Avoid treating to exposed suckers or exposed roots of trees and ornamentals. Do not use on newly seeded turfgrasses until they have been mowed at least twice. Pyridine herbicide. Escalade 4.4L and Escalade Low Odor 4.4L are pre-tank mixtures of fluroxypyr plus 2,4-D, and dicamba.
triclopyr alone, (½ to 1 lb)	Turflon Ester 4L (1 to 2 pts)	Broadleaf weeds; partial bermudagrass & kikuyugrass suppression	Bahiagrass Bermudagrass Kentucky bluegrass	Use high rates only on cool-season turfgrasses. Even at low rates, expect short-term phytotoxicity to warm-season grasses. Repeat applications spaced 4 weeks apart are necessary for hard-to-control broadleaf weeds such as speedwell, parsley piert, violets, ground ivy, and woodsorrel. Newly established turf should be mowed 3 times before application. Picolinic acid herbicide.
triclopyr +2,4-D (¼ to ½ + ½ to 1 lb)	Turflon II Amine (1 to 2 qts) Chaser 3L (1 to 2 qts)		Ryegrass Tall fescue Zoysiagrass	
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 (to ¼ lbs)	Several brands + Sencor 75DF (0.16 to 0.33 lbs)	Crabgrass, goosegrass, dallisgrass, nutsedge, thin paspalum		The tank mix provides better goosegrass control than MSMA alone. Do not apply to turf under stress. Do not apply to tees, greens, or closely mowed turf. Do not add surfactant with this combination. Do not apply within the root zone of shallow rooted ornamentals. Some degree of short-term phytotoxicity can be expected, especially when applied during hot temperatures. Two applications 7 to 10 days apart may be necessary, especially with mature weeds.
metribuzin (¼ to ½ lb)	Sencor 75DF (to 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.

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
diclofop-methyl (¾ to 1 lbs)	Illoxan 3EC (1 to 1.4 qts)	Goosegrass, ryegrass		For use only on golf courses. Young goosegrass plants are easiest to control. The high rate is needed for older plants. Larger, mature goosegrass will not be adequately controlled. Do not mow 24-36 hours after applying. Control takes 2-3 weeks. May cause temporary (7 to 10 days) phytotoxicity. Treat only well established and actively growing turf. Wait 6 weeks before overseeding after the last application. Tank mixing with MSMA, 2,4-D, or metribuzin increases turf burn and may reduce weed control. Restricted Use Pesticide. Aryl-oxy phenoxy herbicide.
ethofumesate (1 to 1½ lb)	Prograss 1.5 EC (2 to 4 qt)	Annual bluegrass, chickweed		Provides annual bluegrass control in dormant bermudagrass overseeded with perennial ryegrass. The first application at 2 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.
pronamide (1 to 1½ lbs)	Kerb 50W (2 to 3 lbs)	Annual bluegrass, ryegrass clumps, <i>Poa trivialis</i> , spring transition		Use only on bermudagrass. Do not apply on or up-slope to desirable bentgrass or overseeded turf as these may run. Movement is encourage when saturated soils are treated and/or heavy (>0.25 in) rainfall occurs within 48 hours of application. Time required for control increases as weeds mature, therefore apply in late fall for optimum results. For slow (3 to 6 weeks) transition, use the low rate of each herbicide listed. For quick transition (1 to 2 weeks), use TranXit, Revolver, or Monument at the high rate in mid-May. Pronamide is a Restricted Use Pesticide. Amide and sulfonyleurea herbicides.
metsulfuron (0.02 lb)	Manor/Blade 60 DF (1 oz)			
rimsulfuron (0.0075 to 0.03)	TranXit 25DG (0.5 to 2 oz)			
foramsulfuron (0.013 to 0.039)	Revolver 0.19L (8.8 to 27 oz)			
trifloxysulfuron (0.005 to 0.015)	Monument 75 WG (0.11 to 0.33 oz)			
rimsulfuron (0.015 to 0.0625 lbs)	TranXit GTA 25WSP (1 to 4 oz)	Annual bluegrass		Apply 7 to 10 days prior to overseeding. Also used for non-selective control of annual bluegrass and ryegrass in non-overseeded bermudagrass. Treat in fall to early winter for best results. Sulfonyleurea herbicide.
simazine (1 lb)	Princep T&O 4L (1 qt)	Annual bluegrass, most winter annual broadleaf weeds		Do not exceed use rates. For winter annual weed control, apply 1 qt/A in early fall (after Oct. 15) and repeat in early winter. Do not apply on or upslope to desirable overseeded turf &/or golf greens. Do not use on bermudagrass during spring 'green-up' or summer unless temporary yellowing and stunting of bermudagrass can be tolerated. Triazine herbicide.

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
foramsulfuron (0.013 to 0.039)	Revolver 0.19L (8.8 to 27 oz)	All cool-season grasses including ryegrass, fescue, bluegrasses, etc., henbit, goosegrass		Controls all cool-season grasses, and for transition, plus henbit and goosegrass (at higher rates). Bermudagrass and zoysiagrass (Meyer) are tolerant. Labeled for all commercial situations such as golf courses, athletic fields, lawns, and sod farms. Sulfonylurea herbicide.
bispyribac-sodium (0.1 to 0.2 lb)	Velocity 80WP (1.3 to 2.6 oz)	Selective annual bluegrass control in overseeded ryegrass	Bermudagrass fairways overseeded with ryegrass, Bentgrass fairways	Apply between Feb. 1 and March 15 just prior to Poa seedhead production. at 1.32 to 2.64 oz/acre in 25 to 50 gallons of water. Use higher labeled rates as Poa matures. Higher rates, however, may cause short-term ryegrass chlorosis. Reapply in 21 to 42 days if Poa regrowth is observed. Treat when temperatures are 50 to 80 F. Treated ryegrass should be overseeded before Oct. 15 th at ≥ 300 lbs seed/acre. No surfactant or adjuvants are needed.
glyphosate (0.375 lbs)	Roundup Pro 4L ($\frac{3}{4}$ 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.
glyphosate + diquat (3.55 to 6.7 lbs)	QuickPRO 76 WG (4.5 to 9 lbs)			
glufosinate ($\frac{3}{4}$ lbs)	Finale 1SC (3 qts)			Use QuickPRO only in areas where bermudagrass and bahiagrass are desirable ground covers. Rates greater than 9 lb/a may result in injury or delayed green-up in highly maintained areas. Apply in 10 to 80 gallons of water per acre Use lower rate for annuals and higher rate for perennials.
diquat ($\frac{1}{4}$ to $\frac{1}{2}$ 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	Bermudagrass, St. Augustinegrass sod production	Do not apply to freshly mowed turf or turf under stress. On Bermudagrass use on 'Tifway' only. Do not use a surfactant. Asulox is for professional applicators only and only for sod production when used on St. Augustinegrass. Carbamate herbicide.
atrazine/simazine (1 to 2 lbs)	Several Brands. Read the label for rates	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.
atrazine + bentazon (to $\frac{3}{4}$ lbs)	Prompt 5L (1.8 to 2.4 pts)			

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
metsulfuron (0.01 to 0.04 lb)	Manor 60DF Blade 60DF Escort 60DF (¼ to 1 oz)	Bahiagrass, foxtails, broadleaf weeds including chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic	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 'Pensicola' bahiagrass. Escort is labeled for 'rough' turf such as roadsides, utility lines, and railroads while Manor and Blade are for fine turf including bermudagrass, St. Augustinegrass, zoysiagrass, centipedegrass, Ky. bluegrass and fine fescue. Do not apply to desirable tall fescue or ryegrass. Some bahiagrass varieties ('Common,' 'Argentine,' & 'Paraguayan') are not completely susceptible. Sulfonylurea herbicide.
dicamba (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 (+ ¼ to ½ lbs)	Several brands contain these mixtures	White clover, spurge, woodsorrel, pennywort plus other broadleaf weeds.		Observe same precaution as dicamba above. Refer to product label for rates. A second application on centipedegrass 7-14 days later may be needed. Use low rates on St. Augustinegrass. A tank mix of atrazine at 1 lb ai/A + 2,4-D & dicamba at 0.2 lb ai/A each provides good control with minimum turf damage when temperatures are 80 F. Phenoxy herbicides. All 2,4-D containing formulations are limited to a maximum number of 2 broadcast applications per treatment site per year.
bromoxynil (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 MCPP will provide increased control but should be used only on established turf. May also be used on bermudagrass, bentgrass, Ky. bluegrass, tall fescue, & ryegrass but not centipedegrass. Restricted Use Pesticide. Nitrile herbicide.
sethoxydim (0.19 to 0.28 lbs)	Vantage 1L (1½ to 2¼ pts)	Crabgrass, goosegrass and other annual grasses suppression of dallisgrass	Centipedegrass Fine Fescue	Apply before weeds mature. Repeat applications are necessary to suppress bermudagrass or bahiagrass. Safe on centipedegrass seedlings after the third mowing. Vantage has oil concentrate pre-added. Cyclohexendione herbicide.
clethodim (0.125 to 0.25 lbs)	Envoy 0.94 EC (17 to 34 fl.oz.)	Common bermudagrass, other grasses such as johnsongrass, barnyardgrass	Centipedegrass Sod Production	This is a 24 (c) Special Local Need Label. Add non-ionic surfactant at 0.25% v/v (1 qt/100 gal). Apply only to actively growing, non-stressed turf. Repeat application 3 to 4 weeks apart may be necessary to suppress bermudagrass. Some discoloration to centipedegrass will occur at the higher rate. Cyclohexendione herbicide.
imazapic (0.063 to 0.125 lb)	Plateau 70 DG (1.43 to 2.86 oz or 1 to 2 water soluble packs)	Bahiagrass, crabgrass, Yellow and Purple nutsedges, annual sedge & <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.

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
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 Bahia grass Bentgrass fairways Fine fescue Kentucky bluegrass	Especially effective for tall fescue clump control. Spot treat tall fescue & perennial ryegrass when in established Kentucky bluegrass, bentgrass fairways, or fine fescue using a hand-held sprayer delivering 1 gallon of spray solution per 1,000 sq.ft. Spray only to wet the tall fescue blades. Avoid excess-application. Repeat treatment may be needed in 60 days. Slow acting. Do not use underneath desirable shrubs or trees. Not for use in sod production. Read and follow all label directions before use. Sulfonylurea herbicide.
ethofumesate (3.0 lb)	Prograss 1.5EC (2 gal)	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) at 1 pt/a may increase control but should not be used on warm-season grasses unless temporary phytotoxicity is acceptable. Aryl-oxy phenoxy herbicide.
fluziafop-butyl (0.05 to 0.1 lbs)	Fusilade T&O II 2EC (3 to 6 oz)	Annual grasses, bermudagrass suppression	Tall fescue Zoysiagrass	Add nonionic surfactant at 0.25% v/v. Begin treatment on zoysiagrass at 3 to 4 fl.oz./A in early June. Repeat application 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. NOT FOR USE ON HOME LAWNS.
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. Multiple applications will be needed for torpedograss/kikuyugrass control. Good soil moisture should be present before treatment. Creeping bentgrass, hybrid bermudagrass, & fine fescue have intermediate tolerance. 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. Quinolincarboxylic Acid 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
mecoprop (MCP) 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 MCP-4 amine (¾ fl oz/1000 sq.ft.) are MCP 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 MCP + 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 early Dec.) plus 2 or 3 times in very early spring (late Feb. 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. 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 <u>gradual transition</u> or <u>conversion</u> from <i>Poa annua</i> to bentgrass. <u>Repeat applications over several years will be required.</u> 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 MAXX 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.
siduron (8 to 12 lbs)	Tupersan 50WP (16 to 24 lbs)	Postemergence bermudagrass suppression		Used alone or in combination with ethofumesate (Prograss) or flurprimidol (Cutless). Control is generally best in spring (March + April + May + early June) and fall (late September + October + November) when the bentgrass is actively growing and the bermudagrass is not. Substituted urea herbicide.
ethofumesate + flurprimidol (see remarks)	Prograss 1.5EC + Cutless 50W (see remarks)	Postemergence bermudagrass suppression;		Apply 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.

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

COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	TURFGRASS USE	COMMENTS
carfentrazone (0.31)	Quicksilver 1.9 L (2.1 oz)	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. Quicksilver at 2.0 oz/acre at 100 GPA when air temperatures are <85F provides excellent silver thread moss control with good bentgrass/ <i>Poa annua</i> tolerance. Do not apply to desirable hybrid bermudagrass. Repeat this every 2 weeks until complete control occurs. Other, but less effective chemical options include Daconil Weather Stik 6L at 4 to 8 oz product per 1000 sq.ft. in 5 to 10 gallons of water; Apply when temperatures are >80F (preferably, >85F); Ironizer (4-0-0-18) granular at 225 oz per 1000 sq.ft.; Iron sulfate alone at 32 oz/1000 sq.ft. or combined with ammonium sulfate at 48 oz/1000 sq.ft. Only use iron containing products when temperatures are cool. Other contact, burn-down products may also work.
ethofumesate (0.5 to 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).

Herbicide (trade names)*	Sedge Control					Turf Tolerance (excluding greens)							
	Annual Sedge	Purple Nutsedge	Yellow Nutsedge	Annual Kyllinga Spp.	Perennial Kyllinga Species	Bermudagrass	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
Imazapic (Plateau)	G	G	G	--	--	G	NR	NR	G	NR	NR	NR	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
Sulfosulfuron (Certainty)	G	G	G	G	G	G	NR	NR	G	G	G	G	G
Trifloxysulfuron (Monument)	G	G	G	G	G	G	NR	NR	NR	NR	NR	G	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 as will repeat applications in 10 to 14 days. Will not satisfactory control purple nutsedge. Not labeled for golf greens. A pre-packaged combination of bentazon and atrazine is available as Prompt. Benzothiadiazole herbicide.
halosulfuron (0.03 to 0.06 lb)	Manage 75WP (to 1 oz) Sempra 75WP (to 1 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 + 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. Sulfonylurea herbicide.
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.
sulfosulfuron (0.035 to 0.17)	Certainty 75WDG (0.75 to 1.25 oz)	Most sedges & kyllinga species Also controls certain broadleaves and annual bluegrass		Repeat application may be needed 3 to 4 weeks after the initial for perennial plants. Will injure/control cool-season turfgrass including tall fescue. Add 0.25% v/v nonionic surfactant. Refer to specific label for additional tolerant turfgrasses and susceptible weeds. Sulfonylurea herbicide.
trifloxysulfuron (0.015 to 0.026)	Monument 75DF (0.33 to 0.56 oz)			
imazaquin (-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 or during spring transition . Not labeled for use on bahiagrass, cool-season grasses, or golf greens. Repeat applications may be required as weeds mature. For wild garlic/onion control, apply at 2 pts/A during December followed with to 1 pt/A in early March. Treated turf may have a compacted growth habit and inhibited seedhead formation. Imidazolinone herbicide.
imazaquin (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*)

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.)

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 (Envoy), diquat (Reward), foramsulfuron (Revolver),trifloxysulfuron (Monument), sulfosulfuron (Certainty), ethofumesate (Prograss), bispyribac-sodium (Velocity), and pronamide (Kerb). Selective suppression is provided by plant growth regulators such as paclobutrazol (Trimmit), flurprimidol (Cutless), and mefluidide (Embark).

Bahiagrass (*Paspalum notatum*)

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 or Blade 60DF at 1 oz/a applied twice 3 to 4 weeks apart works best in tolerant turfgrasses.

Bermudagrass (*Cynodon dactylon*)

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

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. Water-in and repeat in 30 days. 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*)

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*])

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*)

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. Tank mixing Revolver 0.19L at 26 oz/a with MSMA applied twice 3 weeks apart or using an alternating application pattern of MSMA fb Revolver fb MSMA 2 weeks apart also increases control without increasing 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.)

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*)

Products containing atrazine or simazine, foramsulfuron (Revovler) or metsulfuron (Manor or Blade) 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*)

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 Hedgenettle (*Stachys floridana*)

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*)

Preemergence control: split applications 60 days apart of PRE herbicides such as Barricade, Dimension, Pendimethalin, Ronstar, or Surflan. First application 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), Acclaim Extra (13 to 39 oz/a), or Revolver 0.19L at 26oz/a. Avoid treating drought- & heat-stressed turf.

Ground Ivy (*Glechoma hederacea*)

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, fluoxypyr, or triclopyr; dicamba alone also works well. Mid- to late-fall applications are best followed by spring.

Knotweed, Prostrate (*Polygonum aviculare* L.)

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.

Annual *kyllinga* species can be controlled with Basagran, Image, Manage, Certainty, Monument or repeat applications of MSMA or DSMA. Perennial species require repeat applications of Image, Image + MSMA, Certainty, Monument or Manage.

Lawn Burweed or Spurweed (*Soliva pterosperma*)

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, Velocity, or Monument also provide control. Key to control is applications in fall when weeds are small.

Mat Lippia or Matchweed (*Phyla nodiflora*)

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.

***Poa trivialis* in Bentgrass**

Velocity at 2.6 oz/acre twice 3 weeks apart or Certainty at 0.25 oz/a applied 3 weeks apart. Expect short-term phytotoxicity. *Poa trivialis* is suppressed in perennial ryegrass with fenoxaprop (Acclaim Extra) every 2 to 3 weeks from April to September or ethofumesate (Prograss) in Oct. and Nov. Lower rates must be used in bentgrass, thus, poorer control often results. Spot treat with glyphosate (Roundup Pro, others) in late summer just prior to overseeding.

Sandbur (Sandspur) (*Cenchrus* sp.)

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*)

Selective control has been very elusive. Summer atrazine or simazine applications provide approximately 50% control. However, expect temporary turfgrass damage with this. Non-selective control is spot spraying or rope wicking glyphosate (Roundup Pro). If rope wicking, treat in two directions.

Spreading Dayflower (*Commelina diffusa*)

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 or Blade) and foramsulfuron (Revolver). 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. Manor or Blade 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*)

Postemergence control in Ky. bluegrass, fine fescue, zoysiagrass, or bermudagrass - Corsair 75DF at 4 to 5 oz/a or as a spot treatment at 2½ grams/2 gal water. In bermudagrass and zoysiagrass, Revolver 0.19L at 26 oz/a or Monument at 0.32 oz/a. 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*)

Repeat applications of MSMA or DSMA are required every 7 days until complete control is achieved.

Torpedograss (*Panicum repens*)

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) available with quinclorac (Drive) and trifloxysulfuron (Monument). These should be applied 2 or 3 times spaced three to four weeks apart. Expect some minor temporary turfgrass discoloration.

Violets (*Viola* spp.)

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*)

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, Monument at 0.56 oz/a + 2,4-D, or Confront 3L at 1 pt/a have worked well. Repeat in 60 days.

Wild Garlic/onion (*Allium* sp.)

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. Monument and Manor/Blade also work well. In dormant turf, Roundup Pro 4L at 1 pt/a, repeat in 3 to 4 weeks.

Moss

Byrum argentum 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 development 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.), baking soda (6 oz/gal water to drench), hydrogen peroxide, 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. Quicksilver 1.9 L at 2.1 to 7 oz/acre has provided good moss control. Treat when air temperatures are <85F and use at 100 GPA and repeat in 2 to 3 weeks. Products containing potassium salts of fatty acids (e.g., DeMoss) applied weekly at 2 to 3 oz/1000 sq.ft. or formaldehyde 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) should be 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, sulfonyleureas, sethoxydim, and fluzafop.

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	Centipede	Creeping bentgrass	Fine fescues	Ky. bluegrass	Kikuyugrass	Perennial ryegrass	<i>Poa annua</i>	St. Augustinegrass	Tall fescue	Zoysiagrass	Root	Foliar	Overseeding Aid	Golf Greens	
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 (to 1½)	Cutless 50 WP (¾ to 3½ lb to 200 gal water or 0.28 to 1.3 oz/1,000 ft ²)	Root absorbed. Apply to bermudagrass or zoysiagrass golf course fairways, hard-to-mow and trim areas. Provides 4 to 8 week suppression. Must be uniformly applied and irrigated-in with ½ inch water. Flurprimidol does not completely control seedheads. Temporary turf discoloration may follow this treatment. St. Augustinegrass, bahiagrass, and common bermudagrass require the higher rate. Repeat applications every 4 weeks on Tifway bermudagrass with 1.0 lb/A will minimize turf injury. Do not use with SI/DMI fungicides.
	trinexapac-ethyl (0.02 to 0.086)	Primo MAXX 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 (1 ½ 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 ½in. 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 early Dec.) plus 2 to 3 times in very early spring (late Feb. to mid. April) when bentgrass is actively growing. Increased Poa control often occurs if a sterol inhibitor fungicide (DMI) such as Banner Maxx at 1 oz/1000 sq.ft. is applied 2 weeks following each paclobutrazol applications. Do not use if <i>Poa annua</i> populations exceed 70% as severe stand thinning or discoloration may result. Note: This program is designed as a <u>gradual transition or conversion</u> from <i>Poa annua</i> to bentgrass. <u>Repeat applications over several years will be required.</u> Treated Poa will appear noticeably lighter green in color while treated bentgrass may appear 'grainy.' It is highly recommended to start at lower rates (e.g. 8 to 12 oz/a) to ensure proper coverage and application calibration before using more aggressive rates.
	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 MAXX 1EC (1 oz/gallon paint) Primo 25 WSB (½ oz/gallon paint)	Used to extend the life of painted lines which reduces labor costs. The life expectancy of painted lines is extended 7 to 14 days on cool-season grasses and up to 30 days on warm-season grasses. One gallon of paint should treat approximately 1000 sq.ft. of line surface area.
Chemicals for Growth & Color Promotion of Bermudagrass such as Tifdwarf & Tifgreen	Gibberellic Acid (10 grams ai/A)	RyzUp/ProGibb 4% active solution (10 fl oz/A or 0.23 fl oz/1000 sq.ft.)	Apply 10 grams ai/acre weekly or 25 grams ai/acre biweekly in 25 to 100 GPA to promote the growth and prevent discoloration (e.g., purpling) during periods of cold stress and light frosts on bermudagrass such as Tifdwarf or Tifgreen. Do not apply when night temperatures exceed 65F. A combination product of indolebutyric acid + gibberellic acid is available as PGR IV.

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. 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.

Common and Trade Names of Specialty 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
Bispyribac-sodium	-Velocity 80WP
Bromoxynil	-Buctril 2L, Brominal 4L, Bromox 2E, Moxy 2E
Cacodylic Acid	-Montar, Weed Ender
Carfentrazone	-Quicksilver 1.9 L
Carfentrazone + 2,4-D + MCPP + dicamba	-Speed Zone Southern, Power Zone, Speed Zone Northern and Bermuda
Chlorsulfuron	-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, Patron 170 + 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 and/or 2,4-DP	-Trimec Southern, Three-Way Selective, Eliminate DG, 33-Plus, Dissolve, Triamine 3.9 lb/gal, TriEster, Triplet, Trex-San, 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
Diflufenzopyr + Dicamba	-Overdrive 70WG
Dithiopyr	-Dimension 1L, Dimension Ultra 40WSP
Diquat	-Reward LS, Watrol, Vegetrol, Aquatate, Aquatrim II
Diuron	-Karmex

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

Common Name	Trade Name(s)
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
Fenarimol	-Rubigan 1AS, Patchwork 0.78G
Fenoxaprop	-Acclaim Extra 0.57EC
Fluazifop	-Fusilade II T&O, Ornamec
Fluroxypyr	-Spotlight 1.5L
Fluroxypyr + 2,4-D + dicamba	-Escalade 4.4L, Escalade Low Odor 4.4L
Fluroxypyr + MCPP	-Bastion T
Flurprimidol	-Cutless 50WP
Foramsulfuron	-Revolver 0.19L
Gibberellic Acid	-RyzUp
Gibberellic Acid + indolebutyric acid	-PGR IV
Glufosinate	-Finale 1L
Glyphosate	-Roundup Pro 4L, Roundup ProDry, Gly-Flo, Glypro, AquaNeat, Razor, Razor Pro, Rodeo 5.4L, Kleenup Pro, Weed Wrangler, Prosecutor, Touchdown Pro, Trailblazer, Glyphomate 41 (3.8L) + others
Glyphosate + 2,4-D	-Campaign 3.1 L
Glyphosate + Diquat	-QuikPRO
Halosulfuron	-Manage 75WP, Sempra 75WP
Hexazinone	-Velpar 2L
Imazapic	-Plateau 70DG
Imazapic + Glyphosate	-Journey 2.25L
Imazapyr	-Arsenal 2S
Imazaquin	-Image 1.5L, 70DF
Isoxaben	-Gallery 75DF
Isoxaben + trifluralin	-Preen 1.9G, Snapshot TG
Maleic hydrazide	-Royal Slo-Gro
MCPA	-Weedar MCPA 4 lb/gal, MCPA-4 Amine + others
MCPA + clopyralid + dichlorprop	-Chaser Ultra
MCPA + clopyralid + triclopyr	-Battleship
MCPA + MCPP + dicamba	-Trimec Encore, Tri-Power, Trimec Encore DSC
MCPA + MCPP + 2,4-DP	-Triamine II, Tri-Ester II
MCPA + dicamba + triclopyr	-Eliminate, Three-Way Ester II, Horsepower 4.56 lb/gal, CoolPower 3.6 lb/gal
MCPP	-Mecomec 4, Chickweed & Clover Control, Lescopex, MCPP-4 Amine, MCPP-4K + others
MSMA	-Daconate 6, Dal-E-Rad, Crab-E-Rad, MSMA 6.6L, Drexar 530, Buano 6L, 120 Herbicide, Daconate Super, 912 Herbicide, MSMA Turf, Summer Crabicide, Target MSMA, + others
MSMA + 2,4-D +MCPP + dicamba	-Trimec Plus (Quadmec)
Mefluidide	-Embark

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

Common Name	Trade Name(s)
Methyl chlorflurenol	-Maintain CF
Metribuzin	-Sencor 75DF
Metolachlor	-Pennant 7.8 lb/gal, Pennant Magnum 7.62L
Metsulfuron	-Manor 60 DF, Blade 60DF, Escort 60 DF, Patriot 60 WDG
Methyl Bromide	-Brom-O-Gas, Terr-O-Gas, MB 98, MBC
Napropamide	-Devrinol 50 DF, 2G, 10G, Ornamental Herbicide 5G
Napropamide + oxadiazon	-PrePair 6G
Norflurazon	-Predict
Oryzalin	-Surflan AS 4 lb/gal
Oxadiazon	-Ronstar 2G, 50WP
Oxadiazon + benefin	-Regalstar 1.5G
Oxadiazon + bensulide	-Goosegrass/Crabgrass Control 6.56G
Oxadiazon + dithiopyr	-SuperStar
Oxadiazon + prodiamine	-Regalstar II 1.2G
Oxyfluorfen	-Goal 2XL
Oxyfluorfen + oxadiazon	-OO-Herbicide 3G
Oxyfluorfen + pendimethalin	-OH2
Oxyfluorfen + oryzalin	-Rout
Pacllobutrazol	-Turf Enhancer 50WP, 2SC, Trimmit 2SC
Pelargonic Acid	-Scythe, Quik
Pendimethalin	-Pre-M & Pendulum (60 DG, WP, 3.3EC, 2G), Pendulum AquaCap (3.8 CS), Hurdle, Turf Weedgrass Control, Halts, Corral 2.68G
Prodiamine	-Barricade 65WDG, Endurance 65 WDG, Factor 65 WDG, RegalKade 0.5G & 0.37G
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
Sulfentrazone + 2,4-D + MCPP + dicamba	-Surge 2.18L
Sulfometuron-methyl	-Oust 75DG, Spyder 75 DG
Sulfosulfuron	-Certainty 75WDG, Outrider 75WDG

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

Common Name	Trade Name(s)
Triclopyr	-Turflon Ester 4L, Garlon 3A (triclopyr amine), Garlon 4A (triclopyr ester), Pathfinder 1L (RTU), Tahoe 3A, Tahoe 4E
Triclopyr + 2,4-D	-Turflon II Amine, Chaser 3L Ester, Chaser 2 Amine
Triclopyr + clopyralid	-Confront 3L
Triclopyr + MCPP + dicamba	- 3-Way Ester II
Trifloxysulfuron	-Monument 75DF
Trifluralin	-Treflan 5G, Trifluralin 4EC, Trilin 4EC, 5EC
Trinexapac-ethyl	-Primo 1EC, Triple Play, Primo WSP, Primo MAXX
<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 and Jason Norsworthy

SITE/WEED	COMMON NAME (lbs ai/acre)	TRADE NAMES (rate of product/acre)	REMARKS AND PRECAUTIONS (Always Use Drift Control as Recommended by Each Herbicide Label)
Annual Grass and Broadleaf Weed Suppression in Dormant Bermudagrass	sulfometuron (0.047 lb)	Oust 75DG (1 oz)	Oust may be applied once in November to early-February <u>while the bermudagrass is dormant</u> for the control of winter annual grass and broadleaf weeds, and fescue suppression. This treatment may delay greenup of the bermudagrass. This treatment should eliminate the need to mow the winter weeds. It also will help to suppress bahiagrass. Sulfonylurea family.
	glyphosate (0.38 to 0.5 lb)	Roundup Pro 4L (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, tall fescue, and broadleaf weeds. Glyphosate does not provide residual control. Amino Acid Derivative family
	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.
	imazapic (0.125 to 0.188 lb)	Plateau 2L (8 to 12 fl.oz.)	Controls tall fescue, annual ryegrass, and winter annuals. Avoid application during bermudagrass greenup. Will injure green bahiagrass at these rates. Do not exceed 12 oz per acre in one year. See labeled for recommended additive. Imidazolinone family.
	imazapic (0.091 to 0.183 lb) + glyphosate (0.188 to 0.375 lb)	Journey 2.25 L (16 to 32 fl oz.)	Controls tall fescue, ryegrass, winter annuals and specific perennial weeds (see SPECIAL WEED CONTROL section on label for rate for specific weed). See label for recommended tank mixes for additional weed control. A methylated seed oil concentrate at 1.5 to 2 pints per acre can be added to enhance control of specific weeds. Early spring applications made prior to full green-up may delay bermudagrass green-up.
	chlorsulfuron (0.02 to 0.05 lb)	Telar 75DG (0.5 to 1 oz)	For broadleaf weed control. Add 1 qt. surfactant per 100 gal spray. Can be used in bermudagrass and bahiagrass. Sulfonylurea family.

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 (gal) or DSMA 3.6 L (1 gal)	May be applied during summer months every 4 to 6 weeks for suppression or control of emerged weeds. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, broomsedge, johnsongrass, and several broadleaf weeds. Organic Arsenical family.
	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. Some discoloration of bermudagrass may occur. Do not exceed recommended rate. For bahiagrass growth and seedhead suppression, apply a second application at 4.0 fl. oz. product/acre 6 to 8 weeks after the initial application. Amino Acid Derivative family.
	imazapic (0.091 to 0.183 lb) + glyphosate (0.188 to 0.375 lb)	Journey 2.25 L (16 to 32 fl oz.)	Controls tall fescue, summer annuals and specific perennial weeds (see SPECIAL WEED CONTROL section on label for rate for specific weeds). Apply before weeds reach 6 inches in height. See label for recommended tank mixes for additional weed control. A methylated seed oil concentrate at 1.5 to 2 pints per acre can be added to enhance control of specific weeds. Some yellowing of unimproved common bermudagrass turf may occur with application during the growing season. Yellowing will usually disappear in 2 to 4 weeks under favorable weather conditions. Bahiagrass will be severely injured or controlled at these rates.
	imazapic (0.047 to 0.0625 lb)	Plateau 2L (3.0 to 4.0 fl oz)	Apply after full spring green-up of bermudagrass or during the summer months to suppress bahiagrass growth and seedhead development. Controls tall fescue, annual ryegrass, and winter annuals. Add a nonionic surfactant at 0.25% v/v or methylated seed oil at 1.5 to 2.0 pts./acre to the spray mix. Do not apply immediately before or during bermudagrass green-up. A second treatment may be applied 6 to 10 weeks for continued growth suppression. For johnsongrass control, use 8 to 12 oz per acre when plants are 18 to 24 inches tall. Tank mixing with MSMA at 2 lbs ai/acre increases the spectrum and level of weed control and often eliminates a mid-summer application and reduces turf injury. This tank mix increases control of johnsongrass and dallisgrass. Imidazolinone family.
	sulfometuron (0.023lb)	Oust 75DG (0.5 oz)	Oust may be applied after full spring green-up of bermudagrass to suppress bahiagrass growth and seedhead development and for the control of certain broadleaf weeds and johnsongrass. A second treatment may be applied about 6 to 10 weeks later for continued suppression. Be certain that no bermudagrass injury is present before applying the second application. Add 2,4-D + dicamba at 1 to 2 qt/acre to increase broadleaf weed control spectrum. Provides poor control of vaseygrass, broomsedge, and dallisgrass. A nonionic surfactant at 0.25% v/v should be added to the spray mix. Sulfonylurea family.

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 (0.19 lb) + sulfometuron (0.012 lb) or MSMA (2 lb) + sulfometuron (0.012 lb)	Roundup Pro 4L (6 fl oz) + Oust 75DG (0.25 oz) or MSMA 6L (gal) + Oust 75 DG (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.
	metsulfuron	Escort 60DF (0.5 to 1 oz)	For bahiagrass and hemp sesbania control. Add 1 qt. surfactant per 100 gal spray. Common, Argentine, & Paraguayan bahiagrass cultivars are not as susceptible as Pensacola. Also control foxtails and certain broadleaf weeds such as chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic. Sulfonylurea family.
	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.
Grass Weed Control in Centipedegrass	imazapic (0.0625 lb)	Plateau 2L (4 fl oz)	Apply after greenup. Do not apply to drought stressed centipedegrass. Add 0.25% nonionic surfactant. Will provide suppression of many broadleaves. Imidazolinone family.
	sethoxydim (0.19 to 0.28 lb)	Vantage 1.0L (1½ to 2¼ pt)	Vantage may be applied to centipedegrass roadsides to suppress most annual and perennial grasses except dallisgrass. Repeat applications will be needed to suppress bahiagrass or bermudagrass. Apply in 30 to 40 gallons of water per acre. Vantage will not suppress or control broadleaf plants which may be released due to the suppression of grassy weeds. Cyclohexendione family.
	metsulfuron (0.01 to 0.02 lb)	Escort 60DF (¼ to 1 oz)	Note the low use rate. Best control for bahiagrass. A nonionic surfactant at 0.25% by volume (1 qt/100 gal) increases control. Common, Argentine, & Paraguayan bahiagrass cultivars are not as susceptible as Pensacola. Also control foxtails and certain broadleaf weeds such as chickweed, clover, dandelion, plantain, purslane, spurge, woodsorrel, wild onion/garlic. Sulfonylurea family.
General Broadleaf Weed Control including thistles	dicamba (0.5 to 1.0 lb)	Vanquish 4S or Banvel 4S (1 to 2 pts)	Add 1 to 2 qts nonionic surfactant per 100 gal of water. Apply March through July in 20 to 40 gal water per acre as a broadcast application or 100 gal per acre as a handgun or backpack application. Add a tracker dye and drift control agent. Avoid drift especially near sensitive crops. Do not apply within the rootzone of ornamentals. Controls many broadleaf weeds including white clover, spurge, thistles, woodsorrel. Treat small (3-in) tall weeds for best control. May be tank mixed with 2,4-D, Princep, Garlon and other herbicides to broaden weed and brush control spectrum. See label for instruction. Synthetic Auxin family.

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)
	diflufenzopyr (0.05 to 0.1) + dicamba (0.125 to 0.25)	Overdrive 70 WG 4 to 8 ozs	Controls many annual, biennial broadleaf weeds and controls or suppresses many perennial broadleaf weeds. For effective thistle control, apply when in the rosette stage in spring, to early summer but before bud stage. Also controls ragweed, marestalk, kochia, and prickly lettuce. A maximum of 10 ozs can be applied per season per treated acre in railroad, utility, pipeline, highway right-of-ways, and other noncropland sites. Use higher rate when treating large annuals/biennials and perennial weeds. An 80% active nonionic surfactant at 1 qt/100 gals or MSO at 1.5 to 2 pt/acre must be used to achieve consistent weed control. To complement weed spectrum or increase weed control, Overdrive can be tank mixed with various herbicides (see label for tank mix options).
	triclopyr (1.5 lbs)	Garlon 3A (2 qts) or Garlon 4 (1.5 qts)	Apply to actively growing plants. Add 2 to 4 qts. nonionic surfactant per 100 gals of spray. May be tank mixed with 2,4-D to broaden spectrum of weed control. Synthetic Auxin family.
	2,4-D amine (1 to 4 lb)	2,4-D amine (1 to 4 qts)	Controls most annual and perennial broadleaf weeds. Apply as a foliar spray in 30 gal water per acre to young, actively growing vegetation as a broadcast application. Add a drift control agent and be aware of nearby susceptible crops and other desirable vegetation. Synthetic Auxin family.
	glyphosate (0.3 to 0.6 lb) + 2,4-D amine (0.48 to 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Apply prior to green-up for non-selective control of winter weeds, tall fescue, and some weeds resistant to sulfonylurea herbicides. Add a drift control agent and be aware of nearby sensitive crops and desirable vegetation.
	clopymuralid (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. Synthetic Auxin family.
Kudzu	clopymuralid (0.5 lb)	Transline 3L (21 oz)	Used as a broadcast or spot treatment. Add 1 pt nonionic surfactant in 50 to 100 gals water. Apply during periods of active growth from June to Sept. Will also kill locust, redbud, mimosa trees, clover, sericea lespedeza. Synthetic Auxin family.
	triclopyr (see trade name rates)	Garlon 3A (1½ to 2 gal)	Amine formulation. Used as a spot or broadcast treatment. Add 1 to 2 pts surfactant per acre. Coverage should be to wet all leaves, stems, and root collars. Best control is with mid- to late-summer treatments (June to Sept).
		Garlon 4 (1 gal/100 gal solution)	Ester formulation. Used as a spot treatment in 20 to 100 gal water per acre. Add 1 to 2 qts surfactant. Best control is with mid- to late-summer treatments (June to Sept). Refer to label for application guidelines. Synthetic Auxin family.

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. Sulfonylurea family.
Bahiagrass Seedhead Suppression	imazapic (0.03135 to 0.0625 lb)	Plateau 2L (2 to 4 oz)	Foliar (primarily) and root absorbed. Add 1 qt/100 gal nonionic surfactant. Apply to bahiagrass in spring before seedhead formation or 7 days after mowing. Provides some broadleaf weed and nutsedge control. Do not apply to wetlands or to turf less than 3 years old. The 2 oz rate will provide partial control and minimal injury. At the 4 oz rate, treated areas may appear less dense and temporarily discolored, thus, raise the mowing height prior to this treatment. Do not use on St. Augustinegrass or drought- stress bahiagrass. Read and follow label directions before use. Imidazolinone family.
	glyphosate (0.18-0.22 lb)	Roundup Pro 4L (4 to 8 fl oz/10-25 gal water)	Foliar absorbed. Apply to bahiagrass only. Add 2 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 3.1L (16 to 24 oz/A)	
	sulfometuron (0.023 lb)	Oust 75 DG (½ oz/a)	Foliar absorbed. Applied after full spring green-up or 7 to 14 days after first mowing to suppress bahiagrass growth 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. Add 2,4-D &/or dicamba plus 1 qt/acre surfactant to improve broadleaf weed control.
	imazapic (0.0313 to 0.0625 lb)	Plateau 2L (2 to 4 oz)	Add 1 qt/100 gal nonionic surfactant to the 2 oz rate. Surfactant is not needed for the 4 oz rate. May cause temporary injury to turf and thinning of stand. Read and follow label directions before use. Imidazolinone family.

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)
	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. Cyclohexendione family.
	chlorsulfuron (0.012 lb)	Telar 75DG (0.25 oz)	Telar may be applied to suppress tall fescue seedhead production. Apply to established tall fescue that is actively growing in the spring prior to seedhead emergence (usually between March 1 and April 1). Some suppression of the grass growth may occur. This treatment will also help to suppress or control many broadleaf weeds. This treatment may eliminate the need for mowing prior to the application in the summer of MSMA or DSMA as weed control treatments in fescue. Apply in 20 to 30 gallons of water per acre. Sulfonylurea family.
	glyphosate (0.19 to 0.25 lb) + chlorsulfuron (0.012 lb)	Roundup Pro 4L (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 label.
	triclopyr (1 to 2 lbs)	Garlon 4 (4 to 8 qts)	This is a dormant application (Feb., Mar., April). Apply within 10 weeks prior to normal bud break. Add 3 gal crop oil per 100 gals spray solution. Only controls treated (sprayed) limbs. Use drift control as recommended on label. Synthetic Auxin family.
Brush Control (foliar)	triclopyr (2 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. Synthetic Auxin family.
		Garlon 4 (1.5 to 3 gal/100 gal solution)	Used as a spot or if stems are too numerous for cut stump application, use as a broadcast treatment. Add 2 gal crop oil concentrate. Apply as a dormant stem and basal season applications (Feb. through April) at 3 gal/acre rate or during late summer 4 to 8 months after cutting and vegetation is actively growing (1.5 gal/acre rate). Also used under fences, culvert ends, delineators, signs, ditches (no standing water present), and bridge ends. Synthetic Auxin family.

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)
	fosamine (6 to 12 lbs)	Krenite 4S (1½ to 3 gal)	Used as a spot or broadcast treatment. Add nonionic surfactant at 1 qt/100 gals. Use 50 gal of water per acre as a broadcast application or 100 gal water per acre as a handgun application. Thorough plant coverage is necessary for control. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Read label for details. Controls kudzu, blackberry, sumac, multiflora rose, pines, and other woody plants.
	glyphosate (2 to 8.1 lb)	Rodeo 5.4L (to 1½ gal)	Used as a spot or broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal solution. Best results with late summer (Aug to Oct) treatments. May be used in wetlands. Thorough plant coverage is necessary for control. Also used for trimming, curbs, gutters, rip-rap, and drainage ditches. Amino Acid Derivative family.
	glyphosate (2 to 5 lb)	Roundup Pro 4L (2 to 5 qts) generic glyphosate 4L (3 to 7 pts)	Used as a spot treatment as treated grass will be damaged. Best results with late summer (Aug to Oct) treatments. Controls most annual weeds and many perennials such as johnsongrass, dock, milkweed, horsenettle, lespedeza, brambles, multiflora rose, and trumpetcreeper. Apply on a spray-to-wet basis. Grass understory will be killed at the base of the spot treatment. Use a drift control agent as recommended on the label. Add 2 to 4 qts nonionic surfactant per 100 gal solution for generic glyphosate. Amino Acid Derivative family.
	glyphosate (5%) + imazapyr (0.5%)	Roundup Pro 4L (5 gal) + Arsenal 2S (2qt/100 gal)	Apply in a low volume backpack sprayer to the point of leaf wet. Do not spray to drip. Special precaution should be followed to avoid root application in areas of desirable trees and minimize the amount of herbicide to soil contact. Weak on waxy leaf brush.
Brambles	triclopyr (see trade name rates)	Garlon 3A (1½ to 3 qts)	Used as a spot treatment. Add 1 to 2 pts surfactant. Coverage should be to wet all leaves, stems, and root collars. Best control when applied in the spring immediately following flowering or in late summer (Aug to Nov).
		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). Synthetic Auxin family.
	glyphosate (3 to 4 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. Amino Acid Derivative family.
	glyphosate (1 to 1.5% solution)	Roundup Pro 4L (1 to 1½ gal/100 gal)	
	metsulfuron (0.023 lb)	Escort 60DF (2 oz)	Note the low use rate. Add 1 to 2 qt surfactant per 100 gal spray mix. Do not treat desirable bahiagrass. For handgun application, use 100 to 150 gal of spray mix per acre. Use 20 to 40 gal per acre for broadcast application. Controls other plants such as hemp sesbania. Thoroughly spray foliage and stems without excessive runoff. Sulfonylurea family.

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)
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. Synthetic Auxin family.
	imazapyr (1%)	Stalker 2L (2 qt/50 gal basal oil solution)	Add basal oil as the carrier. Treat immediately following mechanical or hand cutting. Only treat cambium region (outside perimeter of cut stump) in a low volume backpack applicator. Imidazolinone family.
	glyphosate (50% solution)	Roundup Pro 4L (1:1 water to herbicide ratio)	Treat May through Sept immediately following cutting. Apply using a backpack sprayer or squirt bottle. Remove wood chips before application. Treat only outside perimeter of cut stump. This is the cambium tissue where the herbicide translocates in the plant. Use a water soluble dye. No drift control agent is needed. Controls oak, sweet gum, and willow. Amino Acid Derivative family.
Injection	2,4-D amine (undiluted injection)	2,4-D amine 4EC (1 to 2 ml of concentrate per injection)	Treat May through October by making injections as near to the root collar as possible. Controls elm, popular, sassafras, willow, and many other woody species. Synthetic Auxin family.
	glyphosate (undiluted injection)	Roundup Pro 4L (1 ml of product per injection)	Inject product into base of tree every 2 to 3 inches around the trunk diameter. Applications should be made during periods of active growth. Controls oak, popular, sweetgum, and sycamore. Amino Acid Derivative family.
Bareground (1 year)	imazapyr (1.0 lb) +	Arsenal 2S (2 qts) +	Make broadcast applications in 40 to 50 gal of water per acre. Apply at 100 gal/acre when using handgun. Controls many annual and perennial broadleaf and grass weeds.
	diuron (2.4 to 4)	Karmex (3 to 5 lb)	
	imazapyr (0.48 to 1 lb) + diuron (3.73 to 8.09 lb)	Sahara DG (6 to 13 lbs)	Tank mix with Roundup Pro for quicker control of emerged vegetation. Do not apply near roots of desirable plants.

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)
Soil Sterilants (>2 years)	bromacil (6 to 12 lb)	Hyvar X-L (3 to 6 gal)	Apply in 100 to 200 gal of water per acre. Rainfall is required for activation. See label for specific recommendations and weeds controlled.
	bromacil (2.4 to 12 lb) + diuron (2.4 to 12 lb)	Krovar I DF (6 to 30 lbs)	Apply prior to weed emergence. If small weeds exist at time of application, add 1 qt nonionic surfactant per 100 gal of spray solution. Rainfall will be needed to carry herbicide into the root zone of weeds. The length of weed control will be extended as rate is increased. See label for specific recommendations and weeds controlled.
Johnsongrass in bermudagrass	imazapic (0.188 to 0.375 lb)	Plateau 70DG (4 to 8 oz) or Plateau 2S (8 to 12 oz)	Add 1 qt nonionic surfactant in 100 gals of spray solution. Apply in 20 to 40 gal per acre. Treat from May to Aug when plants are 18 to 24 inches tall. Controls johnsongrass, crabgrass, ragweed, sandspur, ragweed, tall fescue, prickly sida, trumpetcreeper. Use higher rate for later season treatment. To increase control, add MSMA at 2 lbs ai per acre. Do not mow prior to treatment or within 14 days after treatment. Imidazolinone family.
	imazapic (0.123 to 0.183 lb) + glyphosate (0.246 to 0.375 lb)	Journey 2.25 L (21 to 32 fl oz.)	Apply when johnsongrass has reached 18 to 24 inches in height at the whorl. Use higher rate as density increases. Also controls smutgrass, dallisgrass, bahiagrass, vaseygrass and other <i>Paspalum</i> spp. For best results, use a MSO at 1.5 to 2 pts/acre.
	asulam (3.3 to 6.7 lb)	Asulox 3.34L (1 to 2 gal)	Broadcast treatment when grass is 18 inches or taller. Use higher rate in heavy infestations. A nonionic surfactant can be added at 0.25% by volume. DO NOT TREAT DESIRABLE CENTIPEDEGRASS.
	glyphosate (0.25 to 1% solution)	Roundup Pro 4L (¼ to 1 gal/100 gal)	Used as a spot treatment after plants have reached 12 to 18 inches in height. Best results with summer (June to Aug) treatments. Use higher rate with larger plants. Will cause temporary discoloration and result in turf thinning.
	glyphosate (0.5 to 3 lb) See Remarks	Roundup Pro 4L (0.5 to 3 qts) See Remarks	Used as a broadcast treatment. Use 1 pt/acre for burndown of smaller plants up to 12 inches tall. Use 2 to 3 qt/acre for larger plants in the boot to head stage. Best results with summer (June to Aug) treatments. Generic glyphosate 4L may also be used as a 0.75% solution (3 qts/100 gal spray) as a spot treatment. Use 3 to 4.5 pts/acre for broadcast treatment. Add 2 to 4 qts nonionic surfactant per 100 gal spray. Treat only actively growing plants (June through September). Will cause temporary discoloration and result in turf thinning.
	glyphosate (0.5 to 0.75 lb) + sulfometuron (0.047 to 0.09 lb)	Roundup Pro 4L (16 to 24 fl oz) + Oust 75DG (1 to 2 oz)	Apply after full greenup of bermudagrass and is actively growing. Repeat application of this tank-mix during the growing season is not recommended. Expect 2 to 4 weeks damage to the bermudagrass. A sequential application of Roundup Pro, MSMA, or DSMA may be needed later in the summer if weeds begin to appear. If bermudagrass is sporadically present, this treatment allows it to gradually become the dominant grass. Apply in 20 to 40 gal water per acre. Do not mow prior to treatment or within 14 days after treatment. Expected control is 80 to 85 % with low rates and 90 to 95% at the high rate.

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)
	MSMA (2 lb) or DSMA (3.6 lb)	MSMA 6 L (gal) or DSMA 3.6 L (1 gal)	May be applied April through August every 4 to 6 weeks for suppression or control of emerged weeds. Two to 3 applications may be needed for control. Apply in 40 gal per acre. This treatment will release actively growing bermudagrass and suppress bahiagrass, dallisgrass, johnsongrass, and several broadleaf weeds. Treat when johnsongrass is 12 to 18 in-tall. Tank mixing with Oust at 1 oz/acre during the first treatment will help provide preemergence seedling johnsongrass control. Do not add Oust to subsequent treatments.
	sulfosulfuron (0.035 to 0.062 lb)	Outrider 75 DF (0.75 to 1.33 oz)	Excellent (85 to 95%) for johnsongrass control in bermudagrass. To increase weed control spectrum, add Roundup Pro at 12 to 24 fl oz/acre or MSMA 6L at 3.3 to 4 pts/acre. Add 0.5% nonionic surfactant (2 qts/100 gal spray) or methylated seed oil if Roundup Pro is not used. Treat May through July when plants are small and temperatures above 80F. Sulfonyleurea family.
Ryegrass	proflaminate (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. Sulfonyleurea family.
	sulfometuron (0.04 to 0.09 lb)	Oust 75DF (1 to 2 oz)	Do not add surfactant. Controls winter annual broadleaf weeds, ryegrass, fescue, and suppresses early summer annuals. Fall applications compared to later applications, permit earlier spring green-up of bermudagrass. Sulfonyleurea family.
	glyphosate (0.3 + 0.6 lb) + 2,4-D (0.48 + 0.95 lb)	Campaign 3.1L (1 to 2 qts)	Apply to dormant bermudagrass before March. High rate is needed unless ammonium sulfate (AMS) is added. With this combination, use Campaign at 1 qt/acre + AMS at 17 lbs per 100 gal of carrier. Apply in 20 to 40 gal water per acre. It is not necessary to add a surfactant to Campaign. Treat small weeds (<6-in tall) for best results. Since Campaign is a formulation containing 2,4-D, use care when applying in the vicinity of 2,4-D sensitive crops such as vegetables, cotton, tobacco, fruit trees, and ornamentals. Control is slow (2 to 4 weeks). Use appropriate drift control agent.
	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 sulfonyleurea 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 follow these weed control practices to prevent sulfonyleurea resistant weeds. 1. Tank mix sulfonyleurea 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 sulfonyleurea herbicide. 3. Respray problem areas with a herbicide that has a different mode-of-

action than a sulfonylurea. 4. Rotate the use of sulfonylurea herbicides with herbicides that have a different mode-of-action. Imidazolinone herbicides have the same mode-of-action as sulfonylureas.

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

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	G	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	F	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 inactivate this herbicide, an application of activated charcoal at 400 pounds per acre (or 9.2 pounds per 1000 square feet) would be needed. See the following table for additional conversions of rates per acre to pounds per 1000 square feet.

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

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

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

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

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

Spray Application

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

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

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

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	

AQUATIC WEED CONTROL IN IRRIGATION WATER SUPPLIES

Jack M. Whetstone

Department of Forestry and Natural Resources

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

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

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

Amount of Formulation for Application

Herbicide	Rate*
Aquathol	0.3 to 2.6 gal/acre foot of 4.2 L or 13 to 108 lb of 10G/acre foot or 2.2 to 22.0 lb of 63G/acre foot.
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 3.4 gal of Chelated Copper/acre foot or 0.1 to 0.5 ppm elemental copper.
Fluridone	0.25 to 0.5 gal/surface acre. Check with Company rep for exact rates.
Glyphosate	4.5 to 7.5 pt/surface acre of 5.4L.
Triclopyr	2 to 8 quarts per surface acre of 3L
Sodium Carbonate Peroxyhydrate	3 to 170 pounds per acre-foot of 50G

*Acre foot = 1 surface acre of water (43,560 ft²) 1 foot deep.

Effectiveness of Herbicides for Aquatic Weed Control.

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

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

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 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 crops, 2,4-D should not be used. Certain labels allow irrigation if an approved chemical assay has reached acceptable levels. A few labels allow irrigation with specific waiting periods.			
Diquat	Reward	3 to 5 ³	NR	1	NR
	Weedtrine D	5	NR	5	NR
Endothall	Aquathol K	7 to 25	3	7 to 25	NR
	Aquathol granular	7	3	7	NR
	Aquathol Super K	7	3	7	NR
	Hydrothol 191	7 to 25	3	7 to 25	NR
	Hydrothol 191 granular	7 to 25	3	7 to 25	NR
Fluridone	Avast, Sonar AS, Sonar SRP, Sonar PR, Sonar Q	7-30+	NR	NR	NR
Glyphosate	Rodeo, AquaNeat, Eagre, AquaMaster, AquaPro	NR	NR	NR	NR
Sodium Carbonate Peroxyhydrate	Green Clean	NR	NR	NR	NR
Triclopyr		120 ⁴		NR ⁵	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.

⁴No restriction for established grasses

⁵14 Day Restriction on grazing site and growing. Season grazing restriction on lactating livestock after irrigating pasture

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 $\frac{\text{GPM per nozzle} \times 5940}{\text{MPH} \times \text{width of nozzle spray (inches)}}$
	= $\frac{\text{fl.oz. collected per nozzle in 100 ft} \times 40.8375}{\text{nozzle spacing (inches)}}$	or $\frac{\text{fl.oz. collected per nozzle} \times 4084}{\text{ft. traveled} \times \text{nozzle spacing (inches)}}$
	= $\frac{\text{gallons collected per nozzle} \times \text{no. nozzles} \times 43560}{\text{ft. traveled} \times \text{Swath (ft)}}$	or $\frac{\text{gallons per 1000 sq.ft.}}{0.023}$
Gallons per 1000 sq.ft.	= 0.023 x GPA	
Ounces per 1000 sq.ft.	= 2.94 x GPA	
Gallons Per Minute (GPM):	= $\frac{\text{GPA} \times \text{MPH} \times \text{Swath (ft)}}{495}$	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

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

Active Ingredients (ai)

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

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

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

Metric Prefix Definitions (basic metric unit = 1)

tera	=	10 ¹²	deci	=	10 ⁻¹
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			Liquid		
1 oz/ft ²	=	2722.5 lbs/A	1 oz/1000 ft ²	=	43.56 oz/A = 1.4 qt/A
1 oz/yd ²	=	302.5 lbs/A	1 pt/1000 ft ²	=	5.4 gal/A
1 oz/100 ft ²	=	27.2 lbs/A	100 gal/A	=	2.3 gal/1000 ft ² = 1 qt/100 ft ²
1 oz/1000 ft ²	=	43.46 oz/A = 2.72 lbs/A			
1 lb/A	=	1 oz/2733 ft ² = 8.5 g/1000 ft ²			
100 lb/A	=	2.5 lb/1000 ft ²			
1 yd ³ sand	=	1.3 to 1.5 tons			
1 bushel	=	1¼ ft ³ = 0.046 yd ³			

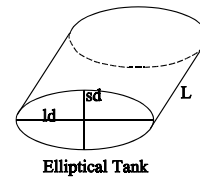
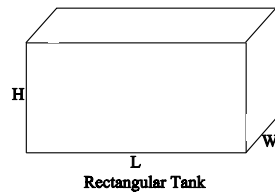
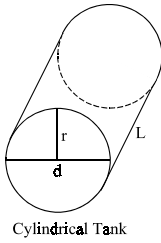
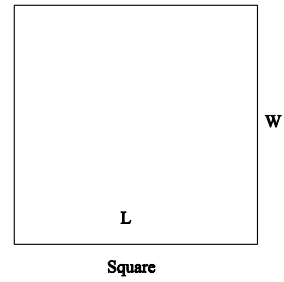
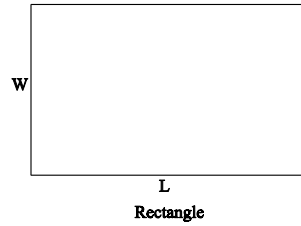
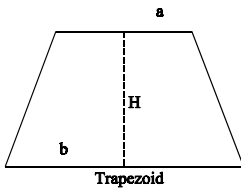
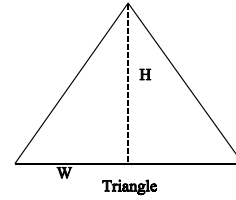
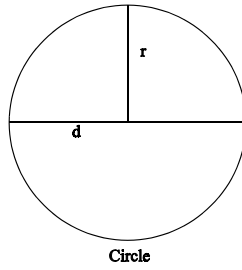
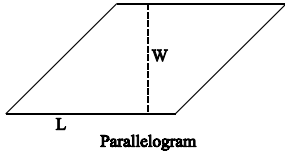
Helpful Calculations and Formulas:

Rectangle, square or parallelogram:	area	=	length (L) x width (W)
Trapezoid:	area	=	[a + (b x h)] ÷ 2
Circle:	area	=	radius (r) ² x 3.1416 (π) = diameter (d) ² x 0.7854
	radius	=	d ÷ 2
	diameter	=	r x 2
	circumference	=	π x d
Sphere:	volume	=	r ³ x 4.1888 = d ³ x 0.5236
Triangle:	area	=	(W x H) ÷ 2
Cylinder:	volume	=	r ² x 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. = 1/2 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/1gal

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 = 1g/100ml = 10g/kg = 1.33 oz by weight/gal water = 8.34 lbs/100 gal water

Approximate Weight of Dry Soil

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

Sand weights (tons): = yd³ x 1.3

Gravel weights (tons): = ft³ x 110

0.5 to 1 inch diameter gravel 2700 lbs/ton

0.25 to 0.375 inch diameter gravel 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) = $\frac{\text{gpm} \times 96.3}{\text{area (ft}^2\text{)}}$

Rainfall (inches) = $\frac{0.5 \times \text{volume collected (ml)}}{(\text{diameter (cm) of opening})^2}$

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
Feet	305	mm
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
ft ³ /1000 ft ²	0.030463	m ³ /100 m ²

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Feet per minute	0.01136	MPH
Feet head of water	0.433	PSI
Foot candle	10.764	Lux
Gallons (gal)	3.785	Liters
Gal	3785	Milliliters
Gal	128	Ounces (liquid)
Gal	0.13368	ft ³
Gal/acre	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	0.014275	oz/a
G/kg	0.10	percent (%)
Grams/liter	1000	PPM
Grams/liter	10	Percent
Grams/liter	0.00834595	lbs/gal
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/ft	0.083	mm/mm
In ²	6.4516	cm ²
In ³	16.3871	cm ³
In ³	0.55411	fl oz
In ³	0.01732	qt
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

Metric Conversion Factors

To Convert	Multiply by	To Obtain
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
L/100 m ²	0.2454	gal/1000 ft ²
L/100 m ²	1.9634	pt/1000 ft ²
Liters/hectare	0.107	Gallons/acre
L/ha	0.314	oz/1000 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/1000 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

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Ounces (fluid)	0.02957	Liters
Ounces (fluid)	29.573	Milliliters
Ounces (fluid)	0.03125	qt.
Ounces (fluid)/acre	0.0731	L/ha
Ounces (fluid)/acre	73.1	ml/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	70	g/ha
oz (weight)/1000 ft ²	3.05	kg/ha
oz (wt.)/ft ²	305.15	g/m ²
Percent (%)	10	g/kg
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/acre-foot	0.3682	g/m ³
Pounds/acre-foot	0.0003682	kg/m ³
Pounds/sq.ft.	4883	Grams/sq.meter
Pounds/1000 ft ²	48.83	Kg/ha
Pounds/1000 ft ²	43.5597	lb/A
Pounds/1000 ft ²	488	g/100 m ²
Pounds/1000 ft ²	0.4883	Kg/100 m ²
Pounds/yd ³	0.0005937	g/cm ³
Pounds/yd ³	594	g/m ³
Pounds/gallon	0.12	Kg/liter
PSI (lbs/sq.in.)	6.89	Kilopascals (kPa)
PSI	0.06895	Bar
PSI	0.068046	atm
PSI	2.31	feet head of water

Metric Conversion Factors

To Convert	Multiply by	To Obtain
Quarts	0.9463	Liters
Qt/A	2.3385	L/ha
Qt/A	0.7346	oz/1000 ft ²
Ton (2000 lbs)	907	kg
Ton (2000 lbs)	0.907	Ton (metric)
Ton (2000 lbs)/acre	2.241	Ton (metric)/ha
Ton (metric)	2,205	lb
Ton (metric)	1,000	kg
Ton (metric)	1.102	ton (2,000 lb)
Yards	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

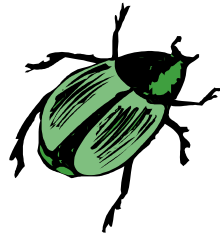
Decimal and Millimeter Length Equivalents

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
		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



To become a member of the **South Carolina Turfgrass Foundation**, complete the following and send a check to the indicated address.

Individual Name: _____

Company/School Name: _____

Address: _____

City: _____

State: _____ Zip: _____

Home telephone: _____

Work telephone: _____

E-mail: _____

Dues Information:

\$35 each

Send this to:

South Carolina Turfgrass Foundation
Sam Cheatham
Executive Director
P.O. Box 1061
Lexington, SC 29071

803-957-0616
803-957-0626 (fax)

