

2006

UNIVERSITY OF
FLORIDA
IFAS EXTENSION

University of Florida's Pest Control Guide for Turfgrass Managers



2006 University of Florida's Pest Control Guide for Turfgrass Managers

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Extension Turfgrass Specialist

This guide supplies information concerning pesticides that can be used for pests in turfgrasses. Because of the risks involved in their handling and use, the U. S. Environmental Protection Agency has classified some pesticide products for restricted use. Such products are identified by the words "RESTRICTED USE PESTICIDE" placed above the product's brand name on the label. Such products must be applied by certified and licensed pesticide applicators or someone working under their direct supervision. Pesticide products that do not bear the "Restricted Use" designation can be purchased and applied by anyone. However, Florida law requires anyone who applies any pesticide to lawns associated with structures (residences, commercial buildings, etc.) for monetary compensation to be licensed or supervised by someone with a license. Persons who apply pesticides to golf courses, parks, cemeteries, and athletic fields must be licensed or supervised by someone with a license only if a restricted use pesticide is applied. Government employees who apply pesticides to the lawns around government buildings and private business property owners who apply pesticides to the lawns around the buildings on their business property must also be licensed. The Florida Department of Agriculture and Consumer Services licenses pesticide applicators. See Pesticide Licensing Category Information (page 6) for specific information on types of licenses required for application of pesticides to turf/lawns in Florida.

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 and state pesticide laws and regulations.

Use of brand names in this publication 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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UNIVERSITY OF FLORIDA TURFGRASS FACULTY

Faculty Name	Phone Number	e-mail Address	Turf Specialty	Assignment Teaching/Research/Extension	% Turf
<i>Apopka</i>					
Dr. John Haydu	407/884-2034	jjh@mail.ifas.ufl.edu	Economics	0/30/70	20
<i>Belle Glade</i>					
Dr. Ron Cherry	561/993-1529	pinespets@aol.com	Insects	0/100/0	40
Dr. Russell Nagata	561/ 993-1557	nagata@mail.ifas.ufl.edu	Plant Breeding	0/100/0	50
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Dr. Monica Elliott	954/577-6315	melliott@ufl.edu	Diseases	0/70/30	50
Dr. Robin Giblin-Davis	954/577-6333	giblin@ufl.edu	Nematodes	0/100/0	50
<i>Gainesville</i>					
Dr. Billy Crow	352/392-1901 ext. 138	wtrc@ufl.edu	Nematodes	5/25/70	70
Dr. Lawrence Datnoff	352/392-3631 ext. 383	ledatnoff@ifas.ufl.edu	Diseases	5/95/0	80
Dr. Michael Dukes	352/392-1864 ext 107	MDDukes@ufl.edu	Ag. Engineering / Turf Irrigation	40/60/0	75
Dr. Eileen Buss	352/392-1901 ext. 116	eabuss@ufl.edu	Insects	5/25/70	75
Dr. Howard Frank	352/392-1901 ext. 128	jhf@mail.ifas.ufl.edu	Biological Control Mole Crickets	10/70/20	20
Dr. Philip Harmon	352/392-3631 ext. 340	pfharmon@ifas.ufl.edu	Diseases	0/40/60	--
Dr. Kevin Kenworthy	352/392-1823 ext. 201	kkenworthy@ifas.ufl.edu	Plant Breeding	30/70/0	100
Dr. Grady Miller	352/392-1831 ext. 375	GMiller@mail.ifas.ufl.edu	Turfgrass Management	70/30/0	100
Dr. Jerry Sartain	352/392-7271	jbs@mail.ifas.ufl.edu	Nutrition, Fertility	30/60/10	100
Dr. Carol Stiles	352-392-3631	cstiles@ifas.ufl.edu	Diseases	15/85/0	100
Dr. Laurie Trenholm	352/392-1831 ext. 374	LTrenholm@mail.ifas.ufl.edu	Urban Landscape Turf Management	0/30/70	100
<i>Milton / Jay</i>					
Dr. Barry Brecke	850/995-3720 ext. 106	bjbe@mail.ifas.ufl.edu	Weed Science	15/85/0	50
Dr. Bryan Unruh	850/995-3720 ext. 108	ibu@ufl.edu	Culture, Turfgrass Management	70/0/30	100

What's New for 2006

Pesticide Licensing

1. **CEU REQUIREMENTS:**

Before January 1, 2005 - All applicators who renew their licenses with CEUs before January 1, 2005, must earn the number of CEUs shown in the table below for each category being renewed. If licensed in more than one category, the applicator must earn the total number of CEUs required for all categories being renewed. Of the number of CEUs required for each primary category, at least 2 of those CEUs must be Core CEUs, and at least half of the CEUs required must be approved for that specific category. The remaining CEUs required must be approved for either Core or the specific category. The same Core CEUs cannot be applied to more than one category. If you are licensed in more than one primary category, you must earn 2 core CEUs per category.

After January 1, 2005 - Applicators who renew their licenses with CEUs after January 1, 2005, must have 4 Core CEUs plus the number of category CEUs shown in the table below. Only 4 Core CEUs are required per license - not 4 Core CEUs per category.

Beginning in 2005, all category CEUs must be approved for the specific category. There will no longer be a requirement for having 2 Core CEUs per primary category, and Core CEUs can no longer be used to meet the required number of category CEUs.

2. **NEW APPLICATOR EXAM STUDY MANUAL**

A new Ornamental and Turfgrass Pest Management manual is now available from the UF/IFAS Extension Bookstore. Applicators who will be taking the certification and licensing exams in the following categories are responsible for studying the manual's entire contents: Ornamental & Turf, Pest Control Operator - Lawn & Ornamental (L&O), and Limited Lawn & Ornamental (Limited L&O). Applicators who are seeking the Limited Commercial Landscape Maintenance certification are responsible for material presented in chapters 1 - 12 and chapters 22 - 24 only. The manual may be ordered from the UF/IFAS Extension Bookstore by calling 1-800-226-1764.

Turfgrass Insect Control

1. Indoxacarb – **Advion™** (DuPont) - New fire ant bait.
2. **Allectus™** (Bayer) Insecticide is registered for control of insect pests. There are different formulations available for the Lawn and Golf Course uses.
3. Chinch bugs were added to the **Dylox® 80 T&O** (Bayer) product.

Turfgrass Disease Control

1. **Insignia™** fungicide (BASF) received additional sites including residential and commercial lawn, athletic turf, and sod.
2. **Armada™** fungicide (Bayer) was released as a premix that includes active ingredients trifloxystrobin and triadimefon. Approved sites include residential and commercial lawn, athletic turf, and sod.
3. **3336 Plus™** (Cleary's Chemical) is a new formulation of thiophanate methyl.
4. Dow (manufacturer of **Fore™** fungicide) as well as manufacturers of all other mancozeb fungicides registered for turfgrass sites have announced successful re-registration of these products with the EPA. As a compromise, manufacturers have agreed to remove residential lawn sites from the labels. Estimated time for the updated label to hit the shelves is reported to be 1.5 to 2 years. Product with the old label will continue to be sold until current stock is gone. Product with the old label may continue to be used on residential lawns indefinitely (until it is used up).

Turfgrass Weed Control

1. Residential and Commercial lawn uses were added to the **Revolver™ (Bayer)** herbicide label.
2. **Sulfosulfuron – Certainty™ (Monsanto)**
- Selective herbicide for control of annual and perennial sedge, grass, and broadleaf weeds in highly managed turf sites. Certainty may be applied to common and hybrid bermudagrass, zoysiagrass, centipedegrass, and St. Augustinegrass. Certainty is labeled for use in commercial and residential turf and on other non-crop sites, including golf course fairways, roughs and tees (do not apply to putting greens), airports, cemeteries, fallow areas, landscaped areas, public recreation areas, residential property, roadsides, schools grounds, sod or turf seed farms, sports fields, and landscaped areas with established woody ornamentals.

3. **Atrazine Restrictions**

Any product that contains greater than 4% atrazine active ingredient is Restricted Use.

This product must not be mixed or loaded within 50 feet of intermittent streams and rivers, natural or impounded lakes and reservoirs. Product must not be applied within 66 feet of the points where field surface water runoff enters perennial or intermittent streams and rivers or within 200 feet of natural or impounded lakes and reservoirs. If this product is applied to highly erodible land, the buffer or setback from runoff entry points must be planted to crop or seeded with grass or other suitable crop.

Products with Sod Farm Use Instructions (Maximum Application Rates)

- For muck or peat soils only: The maximum single application rate is 4.0 lbs a.i./A. A maximum of 6.0 lbs. a.i. may be applied per acre per calendar year.
- For sand soil only: The maximum single application rate is 2.0 lbs. a.i./A. A maximum of 3.0 lbs a.i. may be applied per calendar year.

Lawns and Turf (Not Sod Farms)

- The maximum single application rate for liquid formulations on residential lawns and turf is 1.0 lb. a.i./A (liquid products containing >4% a.i. are restricted use).
- Granular lawn products must be watered in.
- Turfgrass at residential sites (including home daycare facilities, schools, playgrounds, parks, recreational areas and sports fields):
 - Single application = 1.0 lb. a.i./A
 - Maximum per year = 2.0 lbs. a.i./A

Plant Growth Retardants

1. **Governor™** (The Andersons Co.) growth regulator with 5-0-10 fertilizer is a new granular formulation of trinexapac-ethyl. This warm-season-turf formulation works to reduce clippings and mowing frequency.

UNIVERSITY OF FLORIDA'S TURFGRASS PUBLICATION ORDER INFORMATION

NEW - Pests that Wreck Your Grass and Ruin Your Weekend! - SP 327

Did the bugs throw a party in your backyard and forget to invite you? Turn your fresh, green carpet of lawn into a patchy brown mat? Then it's time to learn about grass pests with Pests that wreck your grass and ruin your weekend! Use this colorful, informative booklet to get the lowdown on everything from armyworms to spittlebugs—before they get the better of you.

NEW - Designing, Construction, and Maintaining Bermudagrass Sports Fields - SP 361

This is the Second Edition of the definitive text on the science and practice of Bermudagrass sports fields: a must-have publication for those involved with designing, constructing and/or maintaining football or soccer fields, baseball and softball diamonds. Topics covered? Field drainage (both surface and subsurface); irrigation; turf establishment; "grow-in"; cultural practices; overseeding; pest control; preparations for special events; renovating damaged areas, etc. Spiral bound, 100 pages.

NEW - Florida Lawn Handbook - SP 45

Written in practical language by turfgrass experts, this new highly-anticipated edition is completely up-to-date, with the most current lawn management information. Color plates identify various grass types, weeds, diseases, and insects, including those that are good for your lawn! Chapters cover selection, adaptability, establishment, and maintenance for each type of lawn; soil analysis and fertilization; yearly calendars for lawn care and culture; mowing, watering, and calibrating sprinkler systems and fertilizer spreaders; overseeding for winter color; preparing a lawn for drought and low temperatures; weed and thatch control; safe pesticide application and use; the latest integrated pest management strategies; and complete, illustrated diagnostic information for weeds, diseases, insect problems, nematodes, and other pests. Whether you're an amateur or a pro, The Florida Lawn Handbook is an invaluable aid to growing a beautiful, healthy lawn year round.

NEW - Ornamental and Turf Pest Control (Ornamental and Turf; Lawn and Ornamental Exams) - SM 007

This is the exam preparation and general reference manual for commercial or public applicators seeking certification and licensure to apply pesticides for ornamental and turf pest control. The information includes weeds, insects, diseases, and nematodes affecting ornamental plants and turf and their control. Sections required for study in preparing for certification and licensing exams depend upon the license that an applicator is seeking. The categories, Ornamental & Turf, Pest Control Operator – Lawn & Ornamental (L&O), and Limited Lawn & Ornamental (Limited L&O) are responsible for material contained in the entire manual. Those seeking the Limited Commercial Landscape Maintenance certification are responsible for material presented in chapters 1 – 12 and chapters 22 – 24 only. 368 pp.

Best Management Practices for Florida Golf Courses - SP 141

Complete resource for the golf course manager. Includes information on putting green construction, irrigation water management, fertilizer and fertilization practices, cultural practices, and pest management. Color photographs.

Weeds of Southern Turfgrasses - SP 79

Easy to use, practical weed identification guide contains 427 color photographs of 193 weed species with geographical range and life cycle descriptions. Included is a glossary of taxonomic terms. Indexed by common and scientific names.

Insects & Related Pests of Turfgrass in Florida - SP 140

Identify, learn about and control several insects and related arthropods that are common pests of turfgrass in Florida. Color photographs.

Troubleshooting Lawn Pests (Flashcard set) - SP 180

Learn to recognize organisms commonly found in Florida's turf. Forty-six laminated identification cards identify and describe insects and the damage they cause. Excellent field resource for turf and garden managers.

MCricket CD-ROM (SW-89)

The University of Florida knowledgebase on all ten species of mole crickets found in the United States, including Hawaii, Puerto Rico and the U.S. Virgin Islands. Covers life cycle, distribution, description, biological controls and damage. Includes a graphical identification key. Tutorials instruct the user in concepts of chemical and biological mole cricket control. Now on CD-ROM, plus many full-color photographs added. Runs on Macs and Windows-PCs with a CD-ROM drive and graphical World Wide Web browser software. Available on the WWW at >
<http://www.ifas.ufl.edu/~ent1/mcricket/>

Pests In and Around the Home CD-ROM (SW-126)

The University of Florida's knowledgebase on pests of structures, lawns and landscapes. Contains information on biology, life cycle, identification, distribution, damage, management, and IPM. Contains links to hundreds of definitions, 150+ graphics and 300+ full-color photographs. Runs on Macs and Windows-PCs with a CD-ROM drive and graphical World Wide Web browser software.

Turfgrass Computer Training Tutorials (SW-121 and SW-127)

These two computer-verified training tutorials provide training on turfgrass pests. They are also authorized by the state of Florida for 1 CEU each for recertification purposes. Each contains 50 questions and provides the text and color photographs that the questions are based on. Requires Windows.

Call the **University of Florida Publications** office at 1-800-226-1764 during weekday office hours to place an order.

<p align="center">LICENSES FOR PERSONS WHO APPLY PESTICIDES TO TURF, LAWNS, AND ORNAMENTALS IN FLORIDA</p> <p align="center">Fred Fishel, Ph.D. Pesticide Information Coordinator IFAS, University of Florida</p>				
License Name	Pest Control Operator (PCO) - Lawn and Ornamental	Limited Commercial Landscape Maintenance	Limited Lawn and Ornamental	Ornamental and Turf
Statutory Authority	Chapter 482-Structural Pest Control Act	Chapter 482-Structural Pest Control Act	Chapter 482-Structural Pest Control Act	Chapter 487-Florida Pesticide Law
Responsible Agency and address.	FDACS, Bureau of Entomology & Pest Control 1203 Governor’s Square Blvd., Suite 300 Tallahassee, FL 32301 850/921-4177	FDACS, Bureau of Entomology & Pest Control 1203 Governor’s Square Blvd., Suite 300 Tallahassee, FL 32301 850/921-4177	FDACS, Bureau of Entomology & Pest Control 1203 Governor’s Square Blvd., Suite 300 Tallahassee, FL 32301 850/921-4177	FDACS, Pesticide Certification Office Bureau of Compliance 3125 Conner Blvd., MD-1 Tallahassee, FL 32399-1650 850/488-3314
Who must have this license?	Businesses who perform pest control on lawns and ornamentals. Each business location must have a “certified operator-in-charge.”	Commercial landscape maintenance personnel who apply certain pesticides to plant beds and ornamental plantings	<ul style="list-style-type: none"> • Government employees who apply pesticides to turf and ornamentals associated with government buildings. • Owners or employees of businesses who apply pesticides to the turf and ornamental plantings on their business property. 	Persons who apply or supervise the application of restricted use pesticides on golf courses, parks, cemeteries, and athletic fields.

License Name	Pest Control Operator (PCO) Lawn & Ornamental	Limited Commercial Landscape Maintenance	Limited Lawn & Ornamental	Ornamental & Turf
What kinds of pesticides trigger the licensing requirement?	License required for business to apply any pesticide including herbicides.	License required for application of herbicides for controlling weeds in plant beds and performing IPM on ornamental plants using the following materials: insecticides having the signal word "caution" on the label; insecticidal soaps; horticultural oils; and B.T.	License required for application of any pesticide including herbicides.	License required for application of restricted use pesticides, including herbicides.
Can the licensed applicator supervise unlicensed persons who work under his/her direct supervision?	The certified operator in charge may supervise an unlimited number of employees performing lawn & ornamental pest control from the business location. Each employee must have an identification card issued by FDACS-Bureau of Entomology & Pest Control.	Application by unlicensed persons not permitted. Each person who applies the pesticide must be licensed.	Application by unlicensed persons not permitted. Each person who applies the pesticide must be licensed.	The licensed applicator may supervise up to 15 unlicensed mixer/loaders and applicators at a time.
Qualification for license	The certified operator-in-charge must pass an examination.	<ul style="list-style-type: none"> • Applicator must pass an examination. 	<ul style="list-style-type: none"> • Applicator must pass an examination. 	<ul style="list-style-type: none"> • Applicator must pass an examination.

<p>What are the qualifications to take exams?</p>	<ul style="list-style-type: none"> • 3 years employment as a service employee of a licensed business that performs lawn and ornamental pest control, OR • a degree in entomology, horticulture, agronomy or related field PLUS 1 year experience working for a licensed firm OR • completion of a 1-year entomology program at a public university in FL which specializes in urban pest management and includes practical pest management experience. • a 2 year horticulture technology degree PLUS 1 year of employment as a service employee of licensed pest control business, OR • a specified number of credit hours in entomology, horticulture, etc. PLUS 1 year of employment as a service employee of a licensed pest control business. 	<ul style="list-style-type: none"> • Completion of 8 classroom hours of plant bed and ornamental continuing education training . • Provide proof of being in the landscaping business for a least three years. 	<p>No qualifications</p>	<p>No qualifications</p>
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License Name	Pest Control Operator (PCO) Lawn & Ornamental	Limited Commercial Landscape Maintenance	Limited Lawn & Ornamental	Ornamental & Turf
License renewal	License renewed annually	License renewed annually	License renewed every 4 years	License renewed every 4 years
Recertification requirements	Annual recertification required. Recertify by: <ul style="list-style-type: none"> • Re-examination, OR • Obtain 2 core and 2 L&O classroom hours of acceptable continuing education units. 	Annual recertification required Recertify by: <ul style="list-style-type: none"> • Re-examination, OR • Obtain 4 classroom hours of acceptable continuing education units. 	Recertification required every 4 years. Recertify by: <ul style="list-style-type: none"> • Re-examination, OR • Obtain 4 classroom hours of acceptable continuing education units. 	Recertification required every 4 years. Recertify by: <ul style="list-style-type: none"> • Re-examination, OR • Obtain 4 core <i>and</i> 12 continuing education units by attending programs approved by Department
Fees	<ul style="list-style-type: none"> • \$225 testing fee • \$250 annual business license fee • \$150 annual certified operator-in-charge license fee 	<ul style="list-style-type: none"> • \$150 testing fee. Includes cost of 1-year license, if exam is passed. • \$75 annual license fee 	<ul style="list-style-type: none"> • \$150 testing fee. Includes cost of 4-year license, if exam is passed. • \$25 license renewal fee (4-years) 	<ul style="list-style-type: none"> • No testing fees. • \$60 for a 4-yr. Public license. • \$160 for a 4-yr. Commercial license
Insurance Requirements	Certificate of Insurance which meets requirements for minimum financial responsibility for bodily injury and property damage. <ul style="list-style-type: none"> • Bodily injury: \$100,000 each person & \$300,000 each occurrence; • Property damage: \$50,000 each occurrence & \$100,000 in the aggregate combined or single unit coverage; \$400,000 in the aggregate. 	Same as PCO	No insurance requirements.	No insurance requirements.

License Name	Pest Control Operator (PCO) Lawn & Ornamental	Limited Commercial Landscape Maintenance	Limited Lawn & Ornamental	Ornamental & Turf
What are the limitations on the license	Licensee cannot apply pesticides to golf courses, parks, cemeteries, or athletic fields.	Licensee cannot: <ul style="list-style-type: none"> • Operate a pest control business. • Apply pesticides to turf. • Apply pesticides to golf courses, parks, cemeteries, & athletic fields. Licensee is limited to: <ul style="list-style-type: none"> • Portable handheld 3-gallon compressed air or 5-gallon backpack sprayers. • Application of herbicides in plant beds and ornamental plantings and to IPM on ornamental plants using insecticides with caution label, insecticidal soaps, horticultural oils & B.T. 	Licensee cannot: <ul style="list-style-type: none"> • Operate a pest control business. • Apply pesticides to golf courses, parks, cemeteries, or athletic fields. 	Licensee is limited to pesticide applications to turf and ornamentals on golf courses, parks, cemeteries, & athletic fields.
Training requirements for persons working under direct supervision of the licensed applicator or certified operator	Each person under the direct supervision, direction, and control of certified operator must have at least 5 days of field training in lawn and ornamental pest control. In addition to this training each identification cardholder must receive 4 hours of classroom training in pesticide safety, integrated pest management, and applicable federal and state laws and rules with 6 months after issuance of the card or must have received such training within 2 years before issuance of the card. Each cardholder must receive at least 2 hours of continuing training in pesticide safety, integrated pest management, and applicable federal and state laws and rules by the renewal date of the card.	N/A. Each person making application must be licensed.	N/A. Each person making application must be licensed.	The licensed applicator must provide the following instruction and training to each unlicensed applicator working under their supervision: <ol style="list-style-type: none"> The safety procedures and precautions to be followed in using the product. The need to properly wear and maintain any required personal protective equipment. The common signs of pesticide poisoning. The dangers of eating, drinking or smoking while using pesticides. The need to wash clothing and bathe after working with pesticides. The name and location of a nearby medical facility that can provide emergency treatment for pesticide poisoning.. How and under what circumstances to immediately contact the licensed applicator under whose direct supervision the unlicensed person is working.

INSECT MANAGEMENT

Eileen A. Buss, Assistant Professor and Landscape Entomologist

Several insects and mites feed on grass, but not all of them cause economic or aesthetic damage. Many are harmless, some are beneficial, and some are pests. Some pests may need immediate control, especially if present in great numbers, but others may not be worth the time, effort, or cost of control. Feeding by pests may cause physical damage or just make the grass look temporarily bad. However, insects are only one of many potential causes for thin or brown grass. Diseases, nematodes, drought, nutritional disorders or incorrect chemical applications can also be damaging. Correct identification of the problem can save money and prevent unnecessary pesticide use. After the pest is correctly identified, information can be found on its life cycle, food preference, and habits. It is important to understand these things to properly time any corrective measures.

Scouting or monitoring for damage or pests is an important part of turfgrass management. Examine grass weekly in the spring, summer and fall, or train the mowing crew to record pest activity in areas that are often infested. Exactly how to monitor for each pest depends on where the insect lives or feeds.

Insects and their relatives can feed on the leaf tissue of grasses (e.g., various caterpillars), suck fluids from the leaves and crowns (e.g., southern chinch bugs, spittlebugs, scales, bermudagrass mites), and consume roots (e.g., white grubs, billbugs, mole crickets). In addition, mole crickets tunnel near the soil surface, uprooting grass plants and creating small mounds. Other nuisance organisms (e.g., ants, fleas, ticks, millipedes, chiggers, sowbugs) also occur in the turfgrass, but don't hurt the grass. Rather, they may bite, sting, or occasionally invade buildings.

Southern chinch bugs: To monitor, part the yellowing grass to look for moving insects on plants and in thatch. One option is to cut both ends out of a metal coffee can and insert one end into the turf near the damage, not in the middle of it. Fill the can with water and wait 5 minutes for chinch bugs to float to the top. If none are present, examine at least 3 to 4 other places in the suspected area. Another option is to vacuum declining areas with a Dustbuster or hand-held vacuum, and empty the filter to examine insects. Twenty chinch bugs per square foot is enough to warrant an insecticide application.

Mole crickets, caterpillars, scarab and billbug adults: Monitor by mixing 1 TBSP. (1½ fl. oz.) of liquid dishwashing soap in 1 gallon of water; pour the solution onto 4 square feet near the damage. Insects will crawl to the surface if present in the grass, thatch, or upper soil layer. Examine several suspected areas. Mole cricket tunnels are also most visible early in the morning, when the dew is still present on the grass. If 2 to 4 mole crickets come to the soil surface within 3 minutes of pouring the soap solution, an insecticide application may be justified.

White grubs and billbug larvae: Watch for adult scarab beetles flying at night near lights from March to August. If a problem is suspected, cut 2-4 inches deep in a 1 foot square area of damaged grass. Lay the grass back, check root quality and look for grubs or billbug larvae in the soil. Many white grub species become damaging by late summer.

Cultural Controls: In general, healthy turf is less vulnerable to pests and can recover faster from an infestation. However, avoid overusing water-soluble nitrogen fertilizers because they promote rapid plant growth and succulence, which may attract insect pests or provide existing pests with more nutrients. Over-use of organic fertilizers may also increase the risk of white grub infestations. Use slow release nitrogen when possible. Mow at the correct height for the grass species, reduce thatch, and avoid over-watering. Avoid using flood lights or mercury vapor lights at night, especially in the spring when mole cricket adults and scarab beetles (adults of white grubs) are flying because they are strongly attracted to light.

Natural Enemies: Various invertebrate predators (e.g., ground beetles, earwigs, spiders, and ants) and parasitoids (e.g., tiny wasps or flies) attack turfgrass pests. Although natural enemies rarely completely control pest populations, they do provide some natural suppression, so it is good to conserve them.

Insect Parasitic Nematodes: Commercial preparations of insect parasitic nematodes in the genera *Steinernema* and *Heterorhabditis* can be effective against white grubs and mole crickets. Nematodes work better under moist soil conditions than in dry soils.

Insecticides: Most insecticides kill by either direct contact with the insect or as a stomach poison. Some may also exert a fumigating or vapor action under certain conditions. Products should be selected that will effectively control the pests without injuring the plants, result in another pest outbreak, or kill beneficial and other non-target organisms. Before using an insecticide, consider the following points:

- Select the right product. Only use an insecticide that is recommended to control the target pest and is labeled for the appropriate site (e.g., golf course, athletic field, residential area).
- Use the label rate or recommended amount. Too little won't control the pest; too much is illegal. **Read the container label carefully.**
- Apply it correctly. Thorough coverage is essential. The pesticide must reach the area of the plant where the pest is feeding. Many failures to control pests result from incorrect applications rather than product failure. Adding a wetting agent or spreader-sticker to a spray mixture may improve a pesticide's coverage and help provide greater control. When recommended (especially for white grubs), water the grass (½ to 1 inch of water) immediately after treatment to move the insecticide into the root zone where the insects are feeding. Irrigating also brings insects closer to the soil surface, which increases their contact with the insecticide residues.

Pest	Symptoms	Insecticides	Notes
Ants, Nuisance	Small mounds occur in turf, which may influence how a ball rolls on a golf course green. Ants may also invade buildings from the outside, or nest in trees or ornamental plant beds.	Acephate ² Bifenthrin Carbaryl Cyfluthrin Deltamethrin Lambda-cyhalothrin Permethrin	Ants that invade buildings may also have a nearby honeydew source – look for sap-feeding insects in nearby ornamental plants, shrubs, or trees. A combination of baits and broadcast applications may be necessary for control.
Ants, Imported Fire	These ants nest in large, sandy mounds that go deep into the soil. Any mound disturbance causes ants to immediately defend the nest. Stings result in tiny pustules, pain, itching, and sometimes an allergic reaction.	Baits: Abamectin Fenoxycarb Fipronil Hydramethylnon Indoxacarb Pyriproxifen Spinosad S-methoprene Contact insecticides: Acephate ² Bifenthrin Carbaryl Deltamethrin Fipronil Lambda-cyhalothrin	Scatter granules around the edge of the nest, not on top, for a mound treatment. Ants take the bait into the colony and feed the treated oils to each other, which results in colony death. Some baits work within 48 hours, some take a month.
Beetles (adults)	Some adult beetles make small push-up mounds in turf and others just lay eggs in the plants or soil.	Acephate ² Bifenthrin Carbaryl Cyfluthrin Deltamethrin Lambda-cyhalothrin	Adult beetles may be nuisance pests but often do not damage turf. Many species that do occur in turf are active at night, so apply treatments later in the day, if necessary.
Billbugs (larvae)	Young larvae feed in the stem and older larvae feed on roots. Patches of turf turn yellow, then brown. Grass stems break near the crown, and frass is visible in stems or stolons. Heavily infested sod falls apart when cut.	Preventive: Clothianidin Halofenozide Imidacloprid Curative: Bifenthrin Carbaryl Lambda-cyhalothrin Trichlorfon	Billbug larvae are legless (white grubs have legs). Infestations may be misdiagnosed as early winter dormancy or a slow spring green-up. Bermudagrass and zoysiagrass are preferred hosts, but resistant varieties do exist. Overseeding with endophytic ryegrass may help control populations.

Pest	Symptoms	Insecticides	Notes
Caterpillars (armyworm, cutworm, grass loopers, tropical sod webworm)	Young caterpillars skeletonize grass blades. Older caterpillars may notch the sides or completely eat the grass blades. Damaged grass may look ragged or scalped. In severe infestations, the ground may look like it is moving.	Acephate ² <i>B. t.</i> var. <i>kurstaki</i> Bifenthrin Carbaryl Cyfluthrin Deltamethrin Halofenozide Lambda-cyhalothrin Permethrin Spinosad Trichlorfon	Treat at the first sign of damage. Reduced-risk products like B.t., halofenozide, and spinosad are more effective against younger caterpillars. Caterpillars tend to become a problem in newly established turf, or in early fall, especially if the turf was fertilized heavily in late summer. Most feed at night. Turf can usually recover from caterpillar damage.
Chiggers	Chiggers are immature red mites that bite people, remain attached for 1 to 4 days, and cause severe itching. They tend to occur in areas of tight clothing.	Carbaryl Deltamethrin Lambda-cyhalothrin Permethrin	Insecticidal control is difficult. Keep grass mowed and shrubs pruned. Prevent personal contact by using repellents, and wear protective clothing.
Chinch Bugs, Southern	Injured plants look stunted, yellowed, wilted, or dead. Small dead patches appear first, often near pavement or in stressed areas of St. Augustinegrass.	Bifenthrin Carbaryl Clothianidin Cypermethrin Deltamethrin Lambda-cyhalothrin Permethrin Trichlorfon	Some populations have become resistant to several insecticide chemical classes including pyrethroids. Use a high rate of insecticide with a wetting agent to penetrate thatch. Avoid using low rates in locations with reduced efficacy. Rotate modes of action. Spot treat when possible.
Fleas	Fleas are external, blood-sucking parasites on the skin. The cat flea is most common.	Acephate Bifenthrin Carbaryl Cyfluthrin Cypermethrin Deltamethrin Esfenvalerate Lambda-cyhalothrin Permethrin	For best results, both the pet and lawn should be treated. Flea collars on pets may be necessary. Mow the lawn 1 or 2 days before treatment. Treat the entire area where pets normally sleep or play. Repeat as necessary.
Greenbug (aphids)	This aphid feeds on the phloem tissue of grasses and injects a toxin while feeding. The leaf area around the feeding site turns yellow and dies, sometimes turning burnt orange in color. Irregular dead patches may be surrounded by bands of yellow and rust-colored turf.	Acephate ² Azadirachtin Bifenthrin Carbaryl Cyfluthrin Deltamethrin Imidacloprid Lambda-cyhalothrin Permethrin	This is a major pest of sugarcane and wheat, but has been found on several warm season grasses. Populations can build rapidly. It has a history of insecticide resistance, so resistance management is important. Spot treat up to 3 ft around the visible injury, when possible.
Ground Pearls	These insects suck fluids from grass roots, which make irregular patches of turf look unhealthy. Grass yellows, browns, and dies, especially in hot, dry weather.	None available	Ground pearls are often found by the nematode assay lab when they look for nematodes in soil samples. Properly fertilize, irrigate, and mow at the correct height for the turf species, to keep the turf growing ahead of the damage.

Pest	Symptoms	Insecticides	Notes
Millipedes, Pillbugs, and Sowbugs	These arthropods feed on decaying matter. They are occasional invaders in buildings but do not damage plants.	Bifenthrin Carbaryl Cyfluthrin Deltamethrin Lambda-cyhalothrin Permethrin	Widespread control is not usually recommended. Perimeter treatments may be needed, after gaps around doors and windows are sealed.
Mites, Bermudagrass and Zoysiagrass	Infested turf has short leaves and internodes, resulting in a tufted or “witch’s broom” appearance. Grass leaf tips may be slightly yellowed. Large patches of turf may die, especially during hot, dry weather.	Bifenthrin Deltamethrin Fluvalinate	Grass may outgrow damage if properly fertilized and irrigated. Mow as low as possible, collect, and remove grass clippings to reduce the mite population. Using a wetting agent in the spray should improve coverage.
Mole Crickets	<p>Most damage is caused by nymphs and adults tunneling in the soil, which exposes and dries out roots. Tunnels are easiest to see in the morning, when dew is still on the grass. Damaged turf may thin, then die in large patches. Soil may feel spongy when walked on.</p> <p>Older nymphs make mounds later in the summer, when they come out at night and feed on grass blades.</p>	<p>Acephate² Bifenthrin Clothiandin Cyfluthrin Deltamethrin Fipronil</p> <p>Imidacloprid Lambda-cyhalothrin Permethrin Trichlorfon</p> <p>Baits: Bifenthrin Carbaryl Indoxacarb</p> <p>Beneficial nematodes: <i>Steinernema scapterisci</i></p>	<p>It is important to get insecticides into the soil, either by slit-injection, pre- or post-treatment irrigation (see product labels), or by using a wetting agent in the spray solution. Apply insecticides as late in the day as possible. Mole crickets are deeper in the soil during the day and closer to the soil surface at night. Use soap flushes to determine mole cricket age and density.</p> <p>Baits are most effective later in the summer, when older nymphs come onto the soil surface at night. Do not get baits wet.</p> <p>Beneficial nematodes attack large nymphs and adults, and do not damage plants. They are compatible with most insecticides, but not nematicides, to provide long-term mole cricket suppression.</p>
Scales and Mealybugs	Scales and mealybugs may infest the leaves, crowns, or roots of turf plants. Leaves may first have spots or look yellowed, then turn brown, and die. Heavy infestations of rhodesgrass mealybug look like too much white fertilizer granules have caked around the grass nodes. Some sooty mold may be visible.	Bifenthrin Clothiandin Deltamethrin Imidacloprid	These insects usually do not cause significant damage to turf. They tend to be more damaging on groundcovers. However, a new, white armored scale, <i>Duplochianaspis divergens</i> , has been found in Florida, especially on St. Augustinegrass. It can infest and kill all warm-season grasses under greenhouse conditions, if not controlled.
Spittlebugs	Damage on centipede grass and St. Augustine grass includes yellowing, purple streaking, browning, and turf death. Heavily infested turf feels “squishy” due to spittle masses in the thatch.	Bifenthrin Carbaryl Cyfluthrin Deltamethrin Lambda-cyhalothrin	<p>Treat when most of the spittlebugs have become adults (June to September). Mow and irrigate before application.</p> <p>Spittlebugs cannot survive drought conditions. Avoid over-irrigation of turf to minimize infestation.</p>
Ticks	Ticks are external parasites on skin. They can transmit diseases. Tiny seed ticks or engorged ticks may be seen attached to skin.	Bifenthrin Carbaryl Deltamethrin Lambda-cyhalothrin	Insecticidal control is difficult. Keep grass mowed low to reduce humidity. Prevent personal contact with ticks by using repellents, wear protective clothing, and carefully inspect for and promptly remove any attached ticks.

Pest	Symptoms	Insecticides	Notes
White Grubs	White grubs live in the soil and feed on plant roots. Heavily infested turf may feel spongy when walked on, look yellowed or brown, and pull easily out of the soil. Sod may fall apart when cut. Animals may be seen feeding in an infested area. Swarms of parasitic wasps may hover just above infested turf. Identify grubs by the raster or hair patterns on the tip of their abdomens.	Preventative: Clothianidin Halofenozide Imidacloprid Curative: Carbaryl Trichlorfon Nematodes: <i>Heterorhabditis zealandica</i>	Apply preventative treatments when adult scarab beetles are laying eggs or when eggs start to hatch (April to June in most of Florida, for most species). Masked chafer damage appears in June. Sugarcane grub damage appears in September and October and may continue through January.
Worms	Worms may make small push-up mounds or castings in the turf	None available	Control is not recommended. Worms help aerate the soil and are considered beneficial organisms.

TURFGRASS INSECT AND NUISANCE PEST CONTROL NOTES

¹Only a few formulations of recommended insecticides are listed to serve as examples. Many others are available. 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 use is labeled for use on turfgrass.

²When using acephate, check pH of spray water and adjust to 5.5 - 6.0 when pH is above 7.0. Acephate is not registered for use on residential turf except as a fire ant mound treatment. Acephate will still be registered for broadcast application to turf on golf courses and sod farms.

³Dursban not labeled for residential use.

Common insecticides listed by chemical classes for turf (and sometimes ornamental) use in Florida.

IRAC Mode of Action Classification	Chemical Classes	Mode of Action	Active Ingredients / Chemical Names / Trade Name Examples ¹
1A	Carbamates	Acetylcholine esterase inhibitor	Carbaryl (Sevin)
1B	Organophosphates	Acetylcholine esterase inhibitor	Acephate (Orthene), chlorpyrifos (Dursban), diazinon, dimethoate (Cygon), malathion, trichlorfon (Dylox)
2A	Cyclodiene organochlorines	GABA-gated chloride channel antagonists	Chlordane, lindane
2B	Phenylpyrazoles	GABA-gated chloride channel antagonists	Fipronil (Chipco Choice, Chipco TopChoice)
3	DDT, pyrethroids, pyrethrins	Sodium channel modulators	Bifenthrin (Talstar, Wisdom), beta-cyfluthrin, cyfluthrin (Tempo), cypermethrin (Demon), deltamethrin (DeltaGard), cyhalothrin, lambda-cyhalothrin (Scimitar), esfenvalerate, fenpropathrin, fenvalerate, permethrin (Astro), resmethrin
4A	Neonicotinoids	Nicotinic acetylcholine receptor agonists / antagonists	Acetamiprid (TriStar), clothianidin (Arena), dinotefuran (Safari), imidacloprid (Merit), thiamethoxam (Flagship)
5	Spinosyns	Nicotinic acetylcholine receptor agonists (allosteric) - not group 4	Spinosad (Conserve)
6	Avermectins	Chloride channel activators	Abamectin (Avid, Varsity Fire Ant Bait)
7A	Juvenile hormone analogs	Juvenile hormone mimics	Hydroprene, kinoprene, methoprene (Extinguish)
7B	Fenoxycarb	Juvenile hormone mimics	Fenoxycarb (Award Fire Ant Bait)
7C	Pyriproxyfen	Juvenile hormone mimics	Pyriproxyfen (Distance Fire Ant Bait, Distance IGR)
8A	Alkyl halides	Compounds of unknown or non-specific mode of action (fumigants)	Methyl bromide
11B2	<i>B. t. subspecies kurstaki</i>	Microbial disruptors of insect gut membranes	<i>Bacillus thuringiensis</i> subspecies <i>kurstaki</i> (Dipel)
18A	Diacylhydrazines	Ecdysone agonists / molting disruptors	Halofenozide (Mach 2), tebufenozide (Confirm)
18B	Azadirachtin	Ecdysone agonists / molting disruptors	Azadirachtin (Azatrol, Azatin)
20A	Hydramethylnon	Mitochondrial complex III electron transport inhibitors (Coupling site II)	Hydramethylnon (Amdro)
22	Indoxacarb	Voltage-dependent sodium channel blockers	Indoxacarb (Advion, Provaunt)

¹Specific products are listed for example only. Neither inclusion of products nor omission of similar alternative products in this publication is meant to imply any endorsement or criticism.

DISEASE MANAGEMENT

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Diseases can disfigure plantings around homes, recreational areas, and commercial grounds. 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. " See the end of this section for a table that lists fungicide chemical classes. Read labels carefully. Many fungicides are limited regarding the turfgrass site on which they may be used. Also, many fungicides have a limit on the amount and/or number of applications allowed within a one-year period.

Disease	Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹
Brown Patch Rhizoctonia Blight (<i>Rhizoctonia solani</i>)	Bahia, bermuda, carpet, centipede, rye, St. Augustine, zoysia-grasses	Grass is killed in circular to irregular areas that may expand to several feet in diameter. Leaf fascicles pull easily from plant due to rot at leaf base. Occurs during humid, rainy weather. High N, thatch buildup, and excessive moisture favor disease. St. Augustine, carpet, centipede, zoysia (fall through spring), and rye-grasses (winter) are more affected. This is usually not a summer disease.	Maintain adequate fertility. Avoid excess fast-release nitrogen. Irrigate deeply. Reduce thatch.	propiconazole ² triadimefon trifloxystrobin iprodione ⁵ chlorothalonil ⁵ myclobutanil azoxystrobin Junction ³ mancozeb ⁴ PCNB flutolanil thiophanate-methyl thiram ⁵ vinclozolin polyxin D fludioxonil pyraclostrobin fenarimol
Rhizoctonia Leaf and Sheath Spot <i>R. oryzae</i> , <i>R. zeae</i>)	Bermudagrass	Occurs during summer months when weather is hot and humid. The most commonly observed symptoms are necrotic rings or partial rings that vary from a few inches to a few feet in diameter. Basal leaf area is <u>not</u> rotted. Spots may be observed on leaves at edge of rings.	Unknown at this time, but increasing nitrogen level may be useful.	iprodione ⁵ chlorothalonil ⁵ azoxystrobin mancozeb ⁴ PCNB flutolanil thiram ⁵ The above products may be useful for control.
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.	N may reduce disease. Water deeply only when needed in mornings. 'Bitter-blue' selections are more resistant.	None available. Fungicides used to control other leaf spot diseases will provide suppression.

Disease	Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹
Dollar Spot (<i>Lanzia</i> and <i>Moellerodiscus</i> spp., previously <i>Sclerotinia homoeocarpa</i>)	Bahia, bermuda, centipede, rye, St. Augustine, zoysia-grass, seashore paspalum	On fine textured grasses, spots appear 1-2" in diameter. Spots larger on coarse grasses. Leaves develop marginal, irregular, light tan lesions with reddish brown borders. Active during 60-80°F in fall through spring. Moisture from fog, dew, or irrigation initiate disease. Low soil moisture, thatch, low N and K favor disease.	Avoid N deficiency. Irrigate in morning. Avoid thatch buildup.	propiconazole ² triadimefon iprodione ⁵ chlorothalonil ⁵ myclobutanil Junction ³ mancozeb ⁴ PCNB thiophanate-methyl thiram ⁵ vinclozolin pyraclostrobin boscalid fenarimol
Fairy Ring (<i>Chlorophyllum</i> sp., <i>Marasmius</i> sp., and others) <i>Also see localized dry spots/rings</i>	All grasses	<u>Type I:</u> Dead rings (see Localized Dry Spots / Rings). <u>Type II:</u> Irregularly sized circular to semi-circular bands of lush green turf become apparent. Turf within circular area may decline, brown and thin. Mushrooms may be present. <u>Type III:</u> Mushrooms present, but grass is unaffected.	Difficult to control. Plugging or aerating to allow more water and fertilizer to reach the roots may help. Additional fertilizer will mask Type II rings.	flutolanil azoxystrobin pyraclostrobin *If mushrooms are present, collect and discard into garbage.
Gray Leaf Spot (<i>Pyricularia grisea</i>)	Bermuda, bahia, rye, St. Augustine, centipede-grasses.	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.	Avoid excess N. Irrigate deeply in early morning. Reduce traffic. Mostly a problem on recently planted or atrazine-treated stressed St. Augustinegrass.	polyoxin D (<i>suppression only</i>) propiconazole ² chlorothalonil ⁵ trifloxystrobin thiophanate-methyl azoxystrobin triadimefon mancozeb ⁴ pyraclostrobin

Disease	Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹
<p>“Helminthosporium Leaf Spot” (<i>Bipolaris</i>, <i>Drechslera</i>, <i>Exserohilum</i> spp.)</p>	<p>Bahia, bermuda, rye, St. Augustine, zoysiagrass, seashore paspalum</p>	<p>Symptoms include a leaf spot and 'melting-out' phase. Small oblong purplish to brown leaf spots. Numerous lesions cause leaves to turn reddish-brown and die. Sheath and crown rot may be present. Rye and bermuda are most susceptible. Most prevalent when temperatures range from 68-95°F during mild periods of fall through spring.</p>	<p>Maintain a balanced fertility. Irrigate deeply in the mornings. Raise mower height during disease outbreaks. Reduce thatch. Increase K in areas where disease is known to occur.</p>	<p>propiconazole² trifloxystrobin iprodione⁵ chlorothalonil⁵ myclobutanil azoxystrobin mancozeb⁴ PCNB vinclozolin fludioxonil pyraclostrobin</p>
<p>Pythium Blight (<i>Pythium</i> spp.)</p>	<p>All grasses used for overseeding.</p>	<p>Grass dies in spots or streaks. Initially, the affected grass has a dark color and a greasy appearance. After prolonged moist or foggy periods, the cottony mycelium may be seen on the turf. Pythium can be spread by foot traffic or mowers passing over infected grasses. Occurs during warm, humid, weather after the grass is established.</p>	<p>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.</p>	<p>fosetyl-Al phosphorous acid propamocarb hydrochloride chloroneb etridiazole azoxystrobin Junction³ mancozeb⁴ mefenoxam pyraclostrobin</p> <p><i>To minimize the potential for resistance, alternate between classes of fungicides.</i></p>
<p>Pythium Damping-off (<i>Pythium</i> spp.)</p>	<p>All grasses used for overseeding.</p>	<p>Seed fails to germinate or germination is erratic. Seedlings killed after emergence have water-soaked lesion at the soil surface.</p>	<p>Provide good seed-soil contact to ensure rapid germination. Monitor water closely.</p>	<p>Apron XL (Seed treatment)</p> <p>Fungicides listed for Pythium Blight are useful, but should be applied <u>after</u> seeding.</p>
<p>Pythium Root Rot (<i>Pythium</i> spp.)</p>	<p>All grasses</p>	<p>Roots are dark, soft with few or no feeder roots present. 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.</p>	<p>Avoid overwatering. Aerate compacted and poorly drained soils. Foliar fertilizer treatments may be useful.</p>	<p>fosetyl-Al phosphorous acid propamocarb hydrochloride chloroneb etridiazole azoxystrobin</p> <p><i>To minimize the potential for resistance, alternate between classes of fungicides.</i> Except for fosetyl-Al, water into the root-zone.</p>

Disease	Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹
Rust <i>(Puccinia spp.)</i>	St. Augustine, rye, zoysia-grasses	Small yellow to orange or reddish-brown pustules on the leaves during mild, humid weather. Heavily infected area appears thin and chlorotic. Rye- and zoysia-grasses are most susceptible.	Plant resistant or tolerant varieties. Maintain rapid growth by fertilizing. Mow frequently and remove clippings.	azoxystrobin propiconazole ² triadimefon trifloxystrobin myclobutanil Junction ³ mancozeb ⁴ pyraclostrobin
Slime Mold <i>(Physarum sp., and Fuligo sp.)</i>	All grasses	Grass is covered with gray to black soot-like growth or prominent white or yellow masses during warm, moist weather. Slime molds do not injure turf.	Brush off or wash off the mold with a strong stream of water. Mow.	None are needed.
Bermudagrass Decline <i>(Gaeumannomyces graminis var. graminis)</i> Take-all Root Rot (same pathogen as above)	Bermudagrass St. Augustinegrass Seashore paspalum	Disorder first appears as chlorotic patches 8-24" in diameter. Without control, patches will expand. Grass thins and develops a bare spot. 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. Primarily observed in summer and fall.	Raise mower height by 50% to increase photosynthetic area. Do not scalp St. Augustine-grass when mowed. Increased fertility may help by encouraging rapid cover of affected areas. Foliar fertilizer applications may be useful. Topdress golf course greens frequently. Alleviate all stresses on the grass.	Some <u>preventive</u> control of 'patch' and 'decline' type diseases has been achieved by use of products containing azoxystrobin, myclobutanil, propiconazole, thiophanate-methyl, triadimefon, fenarimol, and pyraclostrobin. Use only preventive rates of triadimefon, propiconazole, and myclobutanil on Bermudagrass. The DMI fungicides are likely to have a negative impact on bermudagrass putting greens when used more than once. Preventive means at least one month <i>prior</i> to development of disease symptoms. Propiconazole would not be recommended on putting greens for the summer months (see footnote #2). Water into the root zone.

Disease	Affected Grasses	Symptoms	Cultural Controls	Fungicides ¹
Anthracnose <i>(Colletotrichum graminicola)</i>	All grasses	<p>The causal fungus can infect leaves, sheaths, and tillers. 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 be observed with a hand lens. It will appear as a dark, cushion-like reproductive structure (acervulus) with black spines (setae) extending from the cushion.</p>	Avoid stressed turf caused by pests, fertility imbalances, or moisture extremes. Thatch removal will be helpful.	fludioxonil propiconazole ² triadimefon chlorothalonil ⁵ trifloxystrobin myclobutanil azoxystrobin thiophanate-methyl pyraclostrobin fenarimol
Localized Dry Spots/Areas/Rings (Basidiomycete fungi, primarily <i>Lycoperdon</i> spp.)	Bermudagrass putting greens, especially those <4 yrs. old	<p>Necrotic (dead) fairy rings may develop an affected area that may appear drought stressed, despite daily irrigations or rainfall, due to the soil repelling water (hydrophobic). "Puffball" mushrooms are usually present throughout the dry area.</p>	<p>The water-repelling (hydrophobic) soil must be broken up and wetted. Spike the dry areas frequently. Irrigate the dry areas by hand several times daily. Apply a soil wetting agent.</p>	<p>Flutolanil and azoxystrobin will stop production of puffball mushrooms but will <u>not</u> solve the dry soil problem, if it is already present.</p>
Algae (various species; primarily blue-green species on surface)	All grasses Most prevalent on putting greens & other turf mowed too short.	<p>Turf areas in partially shaded, damp locations become weak and begin to thin. 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 irrigation penetration.</p>	<p>Improve air circulation and light exposure. Improve drainage and reduce irrigation frequency and amount. Reduce freely available nitrogen at site. On putting greens, verticut or aerify to disrupt algal mats. Topdress frequently.</p>	chlorothalonil ⁵ Junction ³ mancozeb ⁴

DISEASE CONTROL NOTES

¹Only single active ingredient products are listed. Many companies have products that are mixtures of two active ingredients. Presence 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.

²Bermudagrass may exhibit phytotoxicity to propiconazole. See label.

³Phytotoxicity may occur depending on turfgrass varietal differences and with multiple applications of Junction. Apply recommended rate to small area and observe for 7 to 10 days for signs of injury. If phytotoxicity occurs, discontinue use.

⁴Application of mancozeb to residential lawns must be done by a professional pesticide applicator.

⁵Chlorothalonil, iprodione, thiram, and vinclozolin cannot be used on residential (home) lawns. They can be used on sod, business, industrial, and golf course turfgrass sites. See label for applicable restrictions.

Turfgrass fungicides listed by chemical class for use in Florida.

Chemical Group	Common Name ¹ (Trade Name Example ²)	Location of Activity	Mode of Action
Acylalanines (PhenylAmides)	Mefenoxam (Subdue)	Systemic; upward movement	Nucleic acid synthesis
Aromatic Hydrocarbons	Chloroneb (Tersan) Etridiazole (=Ethazole) (Terrazole) Quintozene (=PCNB) (Terraclor, Turfcide)	Contact	Lipids and membrane synthesis
Carbamates	Propamocarb (Banol)	Systemic; upward movement	Lipids and membrane synthesis
Carboxamides	Boscalid (Emerald) Flutolanil (ProStar)	Systemic; upward movement	Respiration (complex II)
Chloronitriles	Chlorothalonil (Daconil)	Contact	
DeMethylation Inhibitors	Fenarimol (Rubigan) Myclobutanil (Eagle) Propiconazole (BannerMaxx) Triadimefon (Bayleton)	Systemic; upward movement	Sterol biosynthesis in membranes
Dicarboximides	Iprodione (Chipco 26GT) Vinclozolin (Curalan)	Local-penetrant	Lipids and membrane synthesis
Dithiocarbamates	Mancozeb (Dithane, Fore) Thiram	Contact	Multi-site contact activity
Inorganic Metals	Copper Hydroxide	Contact	Multi-site contact activity
Phosphonates	Fosetyl-Al (Aliette, Chipco Signature) Phosphorous Acid (Alude, Resyst, Magellan, Vital)	Systemic	Unknown
Polyoxins	Polyoxin D zinc salt (Endorse)	Systemic; upward movement	Glucan and cell wall synthesis
PhenylPyrroles	Fludioxonil (Medallion)	Contact	Signal transduction
QoI-fungicides (Strobilurins)	Azoxystrobin (Heritage) Pyraclostrobin (Insignia) Trifloxystrobin (Compass)	Systemic; upward movement Mesostemic	Respiration (complex III)
Thiophanates (MBC fungicides)	Thiophanate methyl (3336)	Systemic; upward movement	Mitosis and cell division

¹Read all labels to determine the location where it is legal to use the products on turfgrass. For example, some products can only be used on golf courses, whereas others can be used on all turf sites except residential turfgrass.

²Specific products are listed for example only. Neither inclusion of products nor omission of similar alternative products in this publication is meant to imply any endorsement or criticism.

NEMATODE MANAGEMENT

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Nematodes are important pests that commonly contribute heavily to the decline of turf in Florida. However, many times weak turf growth is blamed on nematodes when poor cultural practices, fungi, insects, nutrient problems, soil compaction, poor drainage, or other environmental problems may be the actual cause. Correct diagnosis is important before using of a nematicide. Nematicides vary in their effectiveness against different species of nematodes. Also, no nematicide can be used on all kinds of sites; consult label carefully to be sure a product can be used on a particular site.

DIAGNOSIS

ABOVE-GROUND SYMPTOMS: wilting and slow recovery from wilt; yellowing; decline or “melting out;” irregular shaped areas of declining turf; weed invasion.

ROOT SYMPTOMS: short roots with few branch roots compared to healthy roots; dark color, sometimes with swollen root tips; reduced root system that does not hold soil together when plugs or cores are lifted from the sod.

NEMATODE SAMPLING is the key to correct diagnosis. Obtain Nematode Sample Kits at county extension offices to submit samples to the Florida Nematode Assay Laboratory.

NEMATODE MANAGEMENT TACTICS

IMPROVE TURF MANAGEMENT PRACTICES. If nematode population is high, address the problem with an integrated program of improved cultural practices, planting a different kind of grass if that is warranted and feasible, and chemical control where it is legal and practical. Most grasses can withstand moderate numbers of most kinds of nematodes. Deep, infrequent watering encourages deeper rooting of the turf, enabling grass to reach more water and nutrients than turf having a short root system due to frequent shallow watering. Avoid excess nitrogen fertilization, as this encourages lush, succulent roots conducive to nematode population increases. Instead, use the recommended amounts of fertilizer, but split the amount into more frequent applications. Avoid unnecessary stresses to turf such as mowing too short. Alleviate compacted soils, poor drainage, and other soil physical problems, and correct any nutrient deficiencies.

PLANT A DIFFERENT GRASS. Planting another type of grass (see Table 1) may be a practical choice if the new grass provides acceptable quality, but no variety of any turfgrass is known to have true resistance to all nematodes. Using proper turf management practices (see above) is a more practical approach.

CHEMICAL NEMATICIDES can sometimes give turf short-term relief from stress caused by nematodes. Some are very toxic to plants as well as nematodes and other animal life, so must be used to treat soil to reduce nematode populations and other soil-borne pests before planting. Others are relatively safe for living turf, and can be applied to established grass to reduce nematode activity while the grass is growing. All nematicides are relatively toxic to people, pets, and wildlife, and all are quite soluble in water, so they pose serious threats to people and the environment if used carelessly. Therefore, they are Restricted Use Pesticides for most situations, and their use is strictly regulated.

EFFECTS OF NEMATICIDES ARE ONLY TEMPORARY. Fumigants leave behind no residual active ingredients, so nematodes that survived the treatment (e.g., were too deep to be reached by it or were protected inside fresh roots) or were brought in on new sod or sprigs 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 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 rarely 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 of turf health unless other stresses are also controlled and the nutrients (especially potassium) and water that are needed for good root growth are available.

Table 1. Nematodes and the grasses most affected by each.

Turfgrass	Sting ¹	Lance ²	Stubby-root ³	Spiral ⁴	Ring ⁵	Root-knot ⁶	Cyst ⁷
Bahiagrass	X	X					
Centipedegrass	X		X		X		
St. Augustinegrass	X	X	X	X		X	X
Bermudagrass	X	X	X	X		X	
Zoysiagrass	X	X	X	X		X	
Seashore paspalum	X	X	X	X		X	

¹Sting nematodes damage all grasses; generally found only in very sandy soils.

²Lance nematodes are widely distributed and attack all turfgrasses in Florida.

³There are two types of stubby-root nematodes commonly associated with turfgrasses in Florida, *Paratrichodorus minor* is more common on bermudagrass whereas *Trichodorus proximus* is more common on St. Augustinegrass. St. Augustinegrass appears to be more damaged by stubby-root nematodes than bermudagrass.

⁴Several genera of spiral nematodes are found frequently with turfgrasses. Some genera are considered damaging, while others are not.

⁵Ring nematodes are widely distributed and found associated with all turfgrass types, but are considered important pests only on centipedegrass.

⁶Root-knot nematodes found frequently on most turf types. Their effects on Florida turf are not well known, but they are believed to be injurious at high population densities.

⁷Cyst nematodes normally attack only St. Augustinegrass, and are found most commonly on the east coast and central Florida; high populations can damage this grass severely, and cyst nematodes are very hard to control with chemicals.

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 may enable lance nematodes to become dominant at that location.

ENHANCED BIODEGRADATION is a phenomenon that can reduce the effectiveness of soil-applied pesticides where the same product has been used for a long time. Repeated use of the same chemical encourages build-up of bacteria and other microbes that can metabolize (“digest”) that chemical, so they can destroy it much more quickly than at first. 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. All of the organo-phosphate nematicides that are now used on Florida turf have been subject to enhanced biodegradation somewhere in the world, and the problem can be expected to occur for each in Florida turf, given the “right” circumstances. Enhanced biodegradation of Nematicur has been documented in many Florida turf sites. To minimize the development of this problem for any of these products, it is prudent to use all soil pesticides as little as necessary and 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 one particular pesticide.

SOIL FUMIGATION BEFORE PLANTING. Multi-purpose soil fumigants (Table 2) can be used to treat planting sites before planting new turf or during renovation, to promote rapid and uniform establishment of new turf. Fumigants reduce numbers of nematodes and some soil-borne fungi, insects, and weeds. A loose, open-pored soil permits rapid and uniform diffusion of fumigant vapors. Moderate soil moisture is best: water-filled pores inhibit diffusion of the gas, while very dry soils allow fumes to escape too quickly, which also renders the application ineffective. Soil temperatures should be in the 50°-80°F range.

NEMATICIDES FOR ESTABLISHED TURFGRASS. Always have a nematode assay conducted to verify that nematodes are a potential problem before applying a nematicide. Nematicur is an organophosphate nematicide registered for use on golf courses, cemeteries, and sod farms (in Florida only) (Tables 3 & 4). Aeration, close mowing, vertical mowing, or mechanical thatch removal prior to using Nematicur will improve its penetration into the root-zone and effectiveness. Soil should be moist but not saturated just before treatment. Follow application immediately with 1/10 - 1/2 inch of water as directed by product label instructions. Do not handle or cut sod for at least 30 days after treatment with Nematicur. Do not apply any of these products to newly-planted areas until turf has developed good root systems with secondary roots. The soil fumigants Curfew and Turfcure 376 can be very effective against some nematodes, particularly sting nematode. Fumigants work best on sandy soil without high amounts of organic matter. Soil should be damp, but not saturated.

Table 2. Multi-purpose soil fumigants for treating turf planting sites before planting. All are Restricted Use Pesticides for most applications.

Fumigant Products	Comments
Telone C-17	This liquid fumigant is 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.
Metham-sodium products	Apply these water-soluble materials either as a drench or spray in water or inject through tractor-mounted chisels. Cover with a plastic tarp after application, for maximum benefit.
Methyl bromide / chloropicrin mixture (many brands)	Inject through chisels and cover immediately with a plastic tarp for safety and effectiveness. Usually done by custom applicators who have the special equipment and training to handle these especially toxic pesticides.

Table 3. Minimum levels of common nematodes that may justify nematicide application to established turfgrasses in Florida, and the expected effectiveness of two common nematicides based on their performance in University of Florida research trials.

Kind of Nematode	No./100 cc soil	Comparative Effectiveness of Nematicides	
		Nemacur	Curfew
Sting	10	G*	G
Lance	40	M	M
Stubby-root	40,150**	M	?
Ring	500***	M	M
Root-knot	80	M	?

*G = Good; M = Moderate; P = Poor; ? = Unknown or uncertain

**There are two genera of stubby-root nematodes that are commonly associated with turf in Florida, there are separate thresholds for each genus.

***Ring nematode populations over about 150/100 cc soil may injure centipedegrass; other grasses apparently tolerate much higher levels under most conditions.

Table 4. Nematicides for Established Turf in Florida.

Product	Rate	Legal Uses, Application Comments
Curfew Soil Fumigant	5 gal/A	For use only on golf courses and other sports turf. Must be applied by an authorized custom applicator. 100 ft. barrier to occupied buildings. 24 hour reentry restriction.
Turfcure 376	5 gal/A	For use on golf course fairways, driving ranges, and tees. Must be applied by an authorized custom applicator. 50 ft. untreated buffer to buildings. 48 hour entry restriction.
Nemacur 10G	2.3 lb/1000 sq ft or 100 lb/A	Golf courses, cemeteries; supplemental labeling for use on sod farms in Florida only. Do not use on residential lawns or public recreational areas other than golf courses. Irrigate immediately after application 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. On sod farms, treated sod should not be cut for sod or sod handled for 30 days after treatment. 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 and supplemental labeling for further application restrictions. <u>Applicator must have supplemental labeling in his possession when using Nemacur products on sod farms.</u> Do not apply a total of more than 200 lb/acre/year.
Nemacur 3	9.7 fl oz/1000 sq ft or 3.3 gal/A	Golf courses only; do not use on residential lawns or public recreational areas other than golf courses. Apply dosage in a minimum of 0.5 gallon of water per 1000 sq ft (approx. 20 gallons per acre). Irrigate immediately after treatment with a minimum of 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. Do not use 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 and supplemental labeling for further restrictions.
Sodcure 376	5 gal/A	For use on established turf on sod farms. Must be applied by an authorized custom applicator. 50 ft. untreated buffer to buildings. 48 hour reentry restriction. Because this product is applied by slit irrigation, sufficient time between application and harvest must be allowed so that the sod knits back together.
Telone II	5 to 10 gal/A	Supplemental labeling allows for use on sod farms. Higher rates should be injected at greater depths to avoid phytotoxicity. 100 ft. untreated buffer to buildings, 5 day reentry restriction. Because this product is applied by slit application, sufficient time between application and harvest must be allowed so that the sod knits back together.

WEED MANAGEMENT

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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 weed control, diagnose first why the turf is thin and weeds are invading. Correct the basic problem of unhealthy turf before using any weed control. **HERBICIDES ARE NOT A SUBSTITUTE FOR SOUND CULTURAL PRACTICES.**

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 the major turfgrasses. These plants can be grouped as desirable grasses, weedy grasses, grass-like weeds, sedges and broadleaf weeds. The following is a brief description of representative plants in each group followed by general suggestions for control.

WEEDY GRASSES	
Goosegrass, <i>Eleusine indica</i>	Annual; clump leaning out from center; stem flattened; center of clump white due to white leaf sheath; leaf sheath at center of plant with a thin green stripe in center; seedhead usually with at least one branch below tip; seeds hang under branch.
Crowfootgrass, <i>Dactyloctenium aegyptium</i>	Annual; clump or running; leaf blade with thin stiff hairs along margin, hairs occur from base to tip or at least over half the length of the blade; ligule a thin transparent membrane seen with magnification; seedhead with all branches at the tip; tip of branch with a small sharp point; seeds hang under branch.
Crabgrass, Five species exist in Turf.	<p>India Crabgrass (<i>Digitaria longiflora</i>) - Annual; running aboveground; usually found in dry sites; no hairs on plant; ligule a thin transparent membrane visible to naked eye, but tiny; leaf blades quite short (<2").</p> <p>Blanket Crabgrass (<i>D. serotina</i>) - Annual; running aboveground, mat-forming; short leaves (<2"), hairy; found in moist to wet sites; same ligule as India crabgrass. Native.</p> <p>Southern Crabgrass (<i>D. ciliaris</i>) - Annual; clumps or loosely running; large leaves (>2"), hairy; found in dry sites; same ligule as India crabgrass; seedhead branches from several points.</p> <p>Tropical Crabgrass (<i>D. bicornis</i>) - Annual; clumps or loosely running; large leaves (>2"), hairy; found in dry sites; same ligule as India crabgrass; seedhead branches all from the same point.</p> <p>Smooth Crabgrass (<i>D. ischaemum</i>) - Annual; clumps or loosely running; large leaves (>2"); few hairs on plant; same ligule as India Crabgrass. Found mainly in north Florida and the panhandle.</p>
Thin or Bull Paspalum, <i>Paspalum setaceum</i>	Perennial; clump leaning out from center; hairy or smooth; hard short knotty root structure; seedheads with usually one or occasionally 2 or 3 branches; tiny seeds hang from lower side of branches.
Tropical Signalgrass (a.k.a. Smallflowered Alexandergrass <i>Urochloa subquadriflora</i>)	Perennial from stolons; leaf blade and sheath hairy; seedheads with two to seven branches or "fingers"; angle of branches resembling a "signal flag"; reproduces by seed and stolons.

LEAVES RESEMBLING GRASS LEAVES WITH PARALLEL VEINATION, BUT LACK A LIGULE AND USUALLY A SHEATH	
Doveweed <i>Murdannia nudiflora</i>	Annual; succulent; loosely running; leaf sheath closed; few hairs at base of blade on margin; tiny purple or blue-purple flower; seeds in tiny round capsules; in dayflower family.
Spreading Dayflower <i>Commelina diffusa</i>	Annual; succulent; leaves broadly lance-shaped, with closed sheaths; sheaths short with a few soft hairs on upper margin; flowers with three blue petals, in leaf-like structure open on the margins.
Annul blueeyed-grass <i>Sisyrinchium rosulatum</i>	A winter annual with flattened leaves that cluster at the base of the plant resembling goosegrass when it is small but germinates in the fall and produces a small blue or purple flower in the spring.

BROADLEAVES	
Match-head, <i>Phyla nodiflora</i>	Perennial; running aboveground; leaves opposite; leaves with teeth on margin; plant gray-green; flowers in heads on long stalks resembling a match; flowers at tip purplish to white.
Erect and Prostrate Spurge, <i>Chamaesyce</i> species	Annual; erect or prostrate branched stem; leaves opposite; base of leaf not equal; sap milky. Large number of species occur in FL.
Chamberbitter, <i>Phyllanthus urinaria</i>	Annual; erect branched stem; leaves alternate; fruit or small round capsules on short-stalks hang under the branches; capsules have warts.
Sagotia Beggarweed, <i>Desmodium triflorum</i>	Perennial; runners aboveground; leaves trifoliate (three leaflets), alternate; leaflets on short stalks, broader toward tip; flowers small, purple; fruit with 3 to 5 segments.
Rustweed, <i>Polypremum procumbens</i>	Annual or perennial; forming clumps; leaves opposite, quite narrow, needlelike; flowers white, small 4-lobed; fruit dry, indented at tip; leaves turn a rust color, hence the name.
Common Beggarticks, <i>Bidens alba</i>	Annual; erect branched stem, 2 inches to 9 feet tall; leaves opposite, simple (one leaf) on seedlings, young plants and the lower parts of older plants, leaves compound (3 to 9 leaflets) on mature plants; flowers white; fruits long, narrow and stick to clothing; in Sunflower Family.
Brazil Pusley, <i>Richardia brasiliensis</i>	Perennial; branched spreading stem; plant quite hairy; leaves opposite; leaf margin smooth; root thickened, fleshy, with a thin upper portion so that it is easily broken when pulled; flowers white in a dense cluster at stem tips; fruits with stiff hairs.
Florida Pusley, <i>Richardia scabra</i>	Annual; branched spreading stem; plant quite hairy; leaves opposite; leaf margin smooth; root a tap root, thick near plant and tapering downward; flowers white in a dense cluster at stem tips; fruits with bumps.
Florida Betony <i>Stachys floridana</i>	Perennial; branched erect stem from thin white underground runners and fleshy white tubers; leaves opposite, simple, shovel-shaped, toothed, stalked; flowers pinkish-purple; fruit composed of four nutlets.
Pennywort (dollarweed) <i>Hydrocotyle</i> spp.	Perennial from rhizomes, occasionally with tubers; erect long-stalked leaves with scalloped margins; petiole in center of leaf, "umbrella-like," rather than at edge as in Dichondra; found in moist to wet sites; reproduces by seed, rhizomes, and tubers.
Lawn Burweed (Spurweed) <i>Soliva pterosperma</i>	Low-growing, freely branched winter annual. Leaves opposite, sparsely hairy and twice divided into narrow segments or lobes. Flowers small and inconspicuous. Fruits clustered in leaf axils having sharp spines that can cause injury to humans. Reproduces by seed.

BROADLEAVES	
Virginia Buttonweed <i>Diodia virginiana</i>	Spreading perennial herb with hairy branched stems. Leaves opposite, elliptic to lance-shaped, sessile, joined across stem by membrane. Membrane with a few "hair-like" projections. White tubular flowers with four lobes at each leaf axil along the stem. Flower usually with only two sepals. Fruit green, elliptically shaped, hairy, ridged and at each leaf axil. Reproduces by seed, roots, and stem fragments. Favors moist to wet sites.
Old World Diamond-flower <i>Hedyotis corymbosa</i>	Smooth, spreading summer annual with branched stems. Leaves opposite and narrow. Flowers white, usually two or more on long stalks from the tip of a common long stalk. Flowers midsummer until frost. Found in moist areas especially areas that have been disturbed.

PRE-PLANT NONSELECTIVE WEED CONTROL (Refer to Herbicide Label for Specific Use Listing)			
COMMON NAME	TRADE NAME	WEEDS CONTROLLED	COMMENTS
Methyl bromide	Dowfume MC-2 Bromogas Profume Terrogas	Non-selective	Methyl bromide is formulated as liquid gas under pressure that forms a vapor when released. One to 1½ lb material is required per 100 sq.ft. treated soils. Use the higher rate when soils are heavy in texture, wet, or soil temperatures are below 60 F. Soil should be moist but not saturated. Plow soil 8 to 10 inches in depth and release the chemical under a gas proof (plastic) cover. Most other soil pests are also controlled. Grass can be planted 2 to 3 days after application. Methyl bromide is a toxic material used by professional applicators only. Restricted Use Pesticide.
Metham-sodium (metham) Dazomet	Vapam Basamid Granular	Non-selective	A cover is not required but increased control usually results with one. When a cover is not used, cultivate the soil to the desired depth of metham 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. Dazomet rate is 8 to 10 oz product per 100 sq.ft. of prepared soil surface and should immediately be incorporated with a rotary tiller 4 to 8 inches deep and sealed with water at 15 gals. per 100 sq.ft. Immediately irrigate metham to the depth control is desired. 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. Read and follow all label directions. Metham is now a restricted-use-pesticide while Dazomet is not.
1,3-dichloropropene	Telone II	Non-selective	1,3-dichloropropene applied at rates greater than 35 gallons per acre AND covered with a plastic tarp will provide effective control of most annual and perennial weed species.
Glyphosate	Many	Non-selective Non-selective	Glyphosate is applied only to unwanted vegetation and will not control non-germinated seeds, diseases, nematodes, or other pests. Glyphosate (4 lb/gal) is applied at 2 oz. per gallon of water. 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. Do not apply to desirable plants. Same rates as for RoundUp Pro (comparing acid equivalent) - see label for details.
Diquat	Reward Landscape and Aquatic Herbicide	Non-selective	Burn-down of undesirable above-ground grass and broadleaf weed growth. Spot spray using 1-2 qts per 100 gallons of water. For broadcast application, use 1-2 pints per acre. To obtain expected results, a surfactant must be added.

PRE-PLANT NONSELECTIVE WEED CONTROL (Refer to Herbicide Label for Specific Use Listing)			
COMMON NAME	TRADE NAME	WEEDS CONTROLLED	COMMENTS
Glufosinate ammonium	Finale	Non-selective	Glufosinate is a nonselective water-soluble herbicide for application as a foliar spray for the control of a broad spectrum of emerged annual and perennial grass and broadleaf weeds. Glufosinate (1 lb/gal) is applied at 1.5-4.0 oz per gallon of water. Do not apply to desirable plants.

PREEMERGENCE CONTROLS ¹ (Refer to Herbicide Label for Specific Species and Use Listing)				
<p>Comments. Preemergence herbicides provide 90 to 100 days residual control and require repeat applications for season-long effectiveness. Approximate timings of application for preemergence crabgrass control are: February 1 in south Florida; February 15 in central Florida; and March 1 in north Florida. Goosegrass germinates approximately 3 to 4 weeks later than crabgrass. Adequate soil moisture, both prior to and following 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.</p>				
Grass	Common Name (lbs ai/acre) ²	Trade Name (rate of product/acre)	Weeds Controlled	Comments
Bermudagrass	bensulide (7½ to 12½ lbs)	Bensumec, 4LF (3⅞ gal) Betasan 3.6G (209-348 lbs) Pre-San, Lescosan 7G (107-180 lbs) Pre-San 12.5G (60-100 lbs)	<i>Poa annua</i>	Per the label.
	fenarimol (see comment)	Rubigan 1AS (see comment)	<i>Poa annua</i>	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 day interval for <i>Poa trivialis</i> or bentgrass. 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.

Grass	Common Name (lbs ai/acre) ²	Trade Name (rate of product/acre)	Weeds Controlled	Comments
Bermudagrass	pronamide (1.0 lb)	Kerb 50 W (2.0 lbs)	<i>Poa annua</i> Crabgrass Cool-season grasses	Make application at least 60 days prior to overseeding. Do not apply on or up slope to cool-season turf. Activated charcoal can be used at 2 to 5 lbs/1000 sq. ft. to “deactivate” pronamide when applied closer than 60 days prior to overseeding. Restricted Use Product.
	ethofumesate (1 lb)	Prograss 1.5 EC (2 $\frac{2}{3}$ qt)	<i>Poa annua</i>	Provides <i>Poa annua</i> control in dormant (full, complete dormancy for > 2 months) bermudagrass overseed with perennial ryegrass. The first application should be 30 to 45 days following overseeding. The second should be 21 to 28 days later. Do not apply after February 1. Not labeled for greens or zoysiagrass.
Bermudagrass St. Augustinegrass Zoysiagrass	oxadiazon (3.0 lbs)	Ronstar 2G (150 lbs) Ronstar 50WP	Same as for benefin, goosegrass	For use on Bermuda, St. Augustine, & zoysiagrasses only. Do not apply to wet turf or to golf greens. NOT FOR USE ON HOME LAWNS. Ronstar 50WP can be used only on dormant turf or excessive phytotoxicity will result. Thoroughly irrigate following application to increase effectiveness. Safest preemergence herbicide on newly sprigged or high traffic areas. A combination of oxadiazon plus benefin on a 38% ureaformaldehyde nitrogen fertilizer is available as Regal Star.
Bahigrass Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	benefin (3.0 lbs)	Balan 2.5G (120 lbs) 2.5 Benefin G (120 lbs)	Crabgrass, crowfootgrass, <i>Poa annua</i> , sandbur, some selected broadleaves.	Apply only to well-established turf before annual grass weed seed germination. For continued weed control, a second application 3 months after the initial is required. For <i>Poa annua</i> control, use full rate in September. Minimum 3 month waiting period is required before reseeding. Read the label for irrigations requirements to activate the herbicide. DO NOT APPLY TO IMMATURE TURF , desirable overseeding, or on golf greens.
	benefin (2 lbs) + trifluralin (1 lb)	Team 2G (150 lbs)	Same as for benefin	Same as for benefin. For use by professional applicators only. Good for use in mixed stands containing cool and warm-season turfgrasses.
	bensulide (7 $\frac{1}{2}$ -12 $\frac{1}{2}$ lbs)	Betasan 3.6G (209-348 lbs) Bensumec, 4LF (1 $\frac{7}{8}$ -3 $\frac{1}{8}$ gal) Pre-San 7G (107-179 lbs) Pre-San 12.5G (60-100 lbs) ProTurf Weedgrass Preventer 8.5G (88-147 lbs)	Same as for benefin	Same as for benefin. Safe on overseeded areas and golf greens. If use on putting greens, apply at least 90 days before overseeding. Bensumec 4LF can be applied to dichondra lawns at the time of seeding or any time thereafter.

Grass	Common Name (lbs ai/acre) ²	Trade Name (rate of product/acre)	Weeds Controlled	Comments
Bahigrass Bermudagrass Centipede St. Augustine Zoysiagrass	DCPA (10½ lbs)	Dacthal W-75 (14 lbs)	Same as for benefin, prostrate spurge	Same as for benefin. May be applied to seedlings when they reach 1 to 2 inches in height. A repeat application at a half rate is needed 60 days after the first to extend the control period.
	dithiopyr (.38 - 0.5 lb)	Dimension 1EC (½ gal) Dimension Ultra 2SC (24 oz) Dimension 40 WP (0.95 lbs)	Same as for benefin, goosegrass	Same as for benefin. Do not use within 45 days of seeding or sprigging. A total of 1½ lb ai/A is allowed yearly but not to exceed ½ lb ai/A per application. Preemergence crabgrass control may require a second application 60-90 days after initial application. Postemergence activity on 2-3 leaf stage crabgrass.
	oryzalin (1½ lbs)	Surflan 4AS (1½ qts)	Same as for benefin, goosegrass	Same as for benefin. Use a 1½ + 1½ lb ai/A split application approximately 90 days apart for best results. Longest period (21 days) for preemergence herbicide before required activation by rainfall or irrigation. Spring application on overseeded, cool-season grasses may prematurely thin them.
	oryzalin (1½ lbs) + benefin (1½ lbs)	XL 2G (150 lbs)	Same as for benefin, goosegrass	Same as for benefin
	pendimethalin (2¾ lbs)	Southern Weedgrass Control 2.45G (113 lbs) PRE-M 60DG Pendulum 60 DG (2½-5 lbs) PRE-M 3.3 EC Pendulum 3.3 EC (4.2-7.9 pts) PRE-M/Fertilizer (check label) Pendulum AquaCap 3.8 ME (4.2-7.9 pts)	Same as for benefin, 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 90 days later provides better season-long control, especially when heavy weed pressure is expected. Check the product label for registration on golf greens. Spring application on overseeded, cool-season grasses may prematurely thin them. Sequential applications of Pendulum can be made at 60 to 90 days after initial application for longer control.

Grass	Common Name (lbs ai/acre) ²	Trade Name (rate of product/acre)	Weeds Controlled	Comments
Bahia grass Bermudagrass Centipede grass St. Augustine grass Zoysiagrass	S-metolachlor (1.1 - 2.2 lbs)	Pennant Magnum 7.62L (1.3 to 2.6 pts)	Yellow nutsedge, annual sedge, sprangletop, some annual grass suppression	For use on golf course fairways, sod farms, and commercial lawns. The higher rate will be necessary for turf grown on high organic (i.e., muck) soils. For commercial St. Augustine grass sod production, do not use more than once every 6 weeks and do not apply more than 4.2 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Do not use Pennant Magnum on golf greens, tees, or aprons or within 4 months of overseeding. Irrigate within 7 days after application.
	prodiamine (0.5 - 1.5 lbs)	Barricade 65WG (0.5 - 2.3 lbs) Barricade 4FL (0.6 - 3 pts) RegalKade (check label) ProClipse (check label)	Crabgrass, crowfootgrass, <i>Poa annua</i> , goosegrass, Signalgrass - broadleaf, spurge, Pusley - Florida, etc.	Apply to well-established turf before annual weed seed germination. Barricade may be applied as a single application or in sequential applications to control weeds germinating throughout the year. This is rate dependent. Split applications of low rates may be made at 60 to 90 day intervals. Do not apply to overseeded turf within 60 days after seeding. May be used on newly sprigged bermudagrass at rates not to exceed 0.8 lbs / A. RegalKade formulations are on dry fertilizer carriers.
	isoxaben (1.0 lb)	Gallery 75W (1½ lbs)	Broadleaves	Controls broadleaf weeds. Tank mix with another preemergence herbicide for grass weed control. In order to activate the material, ½" water is needed following application. Not labeled for golf greens. Do not reseed until 30 days after application. Do not apply to newly seeded turf until it has been mowed 3 times.
Bermudagrass Centipede grass St. Augustine grass Bahia grass	napropamide (2.0 lbs)	Devrinol 50WP (4.0 lbs) Devrinol 2G (100 lbs) Devrinol 5G (40 lbs) Ornamental Herb. 5G (80-120 lbs)	Same as for benefin	Do not apply to immature turf. A second application 8 to 10 weeks after the first is suggested. Not recommended for putting greens. Use the reduced rates for turf maintained at lower mowing heights. Irrigate after application. Do not reseed or overseed within six months after application.

Grass	Common Name (lbs ai/acre) ²	Trade Name (rate of product/acre)	Weeds Controlled	Comments
Centipedegrass St. Augustinegrass Zoysiagrass	atrazine/simazine (2.0 lbs-sandy soil) (4.0 lbs-muck soil)	Atrazine Aatrex 4L, 90DG, 80W; Purge Simazine Princep Liquid + others	Same as for benefin plus pennywort (dollarweed), henbit, chickweed, lawn burweed (or spurweed) and some annual sedges. Perennial broadleaf weeds such as will garlic, dock and others usually escape.	SEE NEW LABEL RESTRICTIONS! Apply to centipedegrass, St. Augustinegrass, and zoysiagrass only. Will provide good to excellent weed control with a minimum of growth retardation to newly sprigged, sodded, or plugged turf areas. Effectiveness will be reduced as weeds germinate and 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. Do not apply within the root zone of ornamentals. Do not exceed 1 lb ai/A on newly sprigged turfgrass. Atrazine is a Restricted Use Pesticide.
Seashore Paspalum	prodiamine (0.5 - 1.5 lbs)	Barricade 65WG (0.5 - 2.3 lbs) Barricade 4FL (0.6 - 3 pts) RegalKade (check label) ProClipse (check label)	Crabgrass, crowfootgrass, <i>Poa annua</i> , goosegrass, Signalgrass - broadleaf, spurge, Pusley - Florida, etc.	Apply to well-established turf before annual weed seed germination. Barricade may be applied as a single application or in sequential applications to control weeds germinating throughout the year. This is rate dependent. Split applications of low rates may be made at 60 to 90 day intervals. Do not apply to overseeded turf within 60 days after seeding. May be used on newly sprigged bermudagrass at rates not to exceed 0.8 lbs / A. RegalKade formulations are on dry fertilizer carriers.
	dithiopyr (.38 - 0.5 lb)	Dimension 1EC (½ gal) Dimension Ultra 2SC (24 oz) Dimension 40 WP (0.95 lbs)	Same as for benefin, goosegrass	Same as for benefin. Do not use within 45 days of seeding or sprigging. A total of 1½ lb ai/A is allowed yearly but not to exceed ½ lb ai/A per application. Preemergence crabgrass control may require a second application 60-90 days after initial application. Postemergence activity on 2-3 leaf stage crabgrass.
	oxadiazon (3.0 lbs)	Ronstar 2G (150 lbs)	Same as for benefin, goosegrass	Make application 10 to 14 days after sprigging. Applications made close to the time of sprigging may cause objectional injury.
	pendimethalin	Check specific labels.	Same as for benefin, goosegrass, oxalis, speedwell	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 90 days later provides better season-long control, especially when heavy weed pressure is expected.

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.

Preemergence herbicides for putting greens (Refer to Herbicide Label for Specific Turf Species and Use Listing).

Trade Names	Ingredients	Manufacturer/Distributor
Bensumec 4LF	bensulide	PBI/Gordon Corp.
Pre-San	bensulide	PBI/Gordon Corp.
Weedgrass Preventer	bensulide	Scotts
Goosegrass/Crabgrass Control	bensulide + oxadiazon	Scotts
Southern Weedgrass Control	pendimethalin	Scotts
Betasan	bensulide	Gowan
Kerb	pronamide	Dow AgroSciences
Rubigan	fenarimol	Gowan

Turfgrass Tolerance to Preemergence Herbicides (Refer to Herbicide Label for Specific Species Listing)							
Herbicides	Bahia-grass	Bermuda-grass ¹	Centipede-grass	St. Augustine-grass	Seashore Paspalum	Zoysia-grass	Overseed Ryegrass
atrazine (Aatrex)	NR ²	NR	S	S	NR	I-S	D
benefin (Balan)	S	S	S	S	NR	S	NR
benefin+oryzalin (XL)	S	S	S	S	NR	S	NR
benefin+trifluralin (Team)	S	S	S	S	NR	S	NR
bensulide (Betasan, Bensumec, PreSan)	S	S	S	S	NR	S	I-S
bensulide+oxadiazon	NR	S	NR	NR	NR	S	NR
DCPA (Dacthal)	S	S	S	S	NR	S	NR
dithiopyr (Dimension)	S	S	S	S	S	S	I
ethofumesate ³ (Prograss)	NR	S - dormant	NR	I	NR	NR	S(D)
isoxaben (Gallery)	S	S	S	S	NR	S	NR
fenarimol (Rubigan)	NR	S	NR	NR	NR	NR	S
metolachlor (Pennant Magnum)	S	S	S	S	NR	S	D
napropamide (Devrinol)	S	S	S	S	NR	NR	NR
oryzalin (Surflan)	S	S	S	S	S	S	NR
oxadiazon (Ronstar)	NR	S	NR	S	S	S	I
pendimethalin (Pendulum)	S	S	S	S	S	S	I
prodiamine (Barricade)	S	S	S	S	S	S	I
pronamide (Kerb)	NR	S	NR	NR	NR	NR	D
simazine (Princep Liquid)	NR	I	S	S	NR	S	D

¹Non golf green only.

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; D=Damaging - do not use; NR=Not Registered for use on this turf species.

³Ethofumesate is labeled only for Dormant bermudagrass overseeded with perennial ryegrass.

Preemergence Herbicide Efficacy Ratings																			
	atrazine	benefin	benefin + oryzalin	benefin + trifluralin	bensulide	bensulide + oxadiazon	DCPA	dithiopyr	ethofumesate	fenarimol	isoxaben	metolachlor	napropamide	oryzalin	oxadiazon	pendimethalin	proflaminate	pronamide	simazine
PERENNIAL WEEDS																			
bahiagrass	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
bermudagrass	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
dallisgrass	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
nutsedge, purple	P	P	P	P	P	P	P	P	P	P	P	P-F	P	P	P	P	P	P	P
nutsedge, yellow	P	P	P	P	P	P	P	P	P	P	P	G	P	P	P	P	P	P	P
tall fescue	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	G	F
wild garlic/onion	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
ANNUAL GRASSES																			
<i>Poa annua</i>	E	E	E	E	F	F-G	G	G-E	G-E	G	P-F	G	G	G	G	G	E	E	E
crabgrass	F	E	E	E	E	E	G	G-E	G	P	P	G	G-E	E	E	E	E	F	F
crowfootgrass	P-F	G	G	G	G	G		G		P	P	F	F	G	G	G	G		
goosegrass	P	F	G	G	F	G	F	F-G		P	P	F	G	F-G	E	F-G	F-G	F	F
sandbur	P	F	F-G	G	G	F-G	F	F		P	P	F	F	G	F	G	G		
BROADLEAF WEEDS																			
chamberbitter (niruri)	G									P	G								
common chickweed	E	G	G	G	P	P	E	G	G	P	E	F	E	G	P	G	G	E	E
corn speedwell	E	E	E	E	P	P	G	G		P	G-E	G	E	P	G	E	E	G	G
cudweed	E	P	P	P		P				P	G		G	P	P	G	P	P	
dandelion	F	P	P	P	P	P				P	G			P	P	P	P	P	P
dichondra	G	P	P	P	P	P				P				P	P	P	P	P	P
docks	G	P	P	P	P	P				P				P	P	P	P	P	P
doveweed	G	P	P	P	P	P			P	P				P	P	P	P	P	G
Florida betony	E	P	P	P	P	P				P				P	P	P	P	P	P
ground ivy		P	P	P	P	P				P				P	P	P	P	P	P

Preemergence Herbicide Efficacy Ratings																			
	atrazine	benefin	benefin + oryzalin	benefin + trifluralin	bensulide	bensulide + oxadiazon	DCPA	dithiopyr	ethofumesate	fenarimol	isoxaben	metolachlor	napropamide	oryzalin	oxadiazon	pendimethalin	proflaminate	pronamide	simazine
BROADLEAF WEEDS																			
henbit	E	G	G	G	P	P	F	G		P	G		P	G	P	G	G	F	E
hop clovers	E	P	G	G	P	F				P				F	G	G	P	P	E
knotweed	E		G	G	G	G		G		P	G		G	F	G	G		G	G
lespedeza	E	P	P	P				G		P				P		P	P		E
mallow		P	P	P	P	P				P	G			P	P	P	P	F	P
mock strawberry		P	P	P	P	P				P				P	P	P	P	P	P
mouseear chickweed	E	E	E	E	P	P	G	G		P	G			P	P	G	G	G	G
mugwort		P	P	P	P	P				P				P	P	P	P	P	P
mustards	E				G	G-E	P	G		P	G				E			F	F
parsley piert	E	P	P	P	E	G-E		G		P					G	P	P	P	G
pennywort (dollarweed)	E	P	P	P	P	P				P	G			P	P	P	P	P	P
plantains	G	P	P	P	P	P				P	G			P	P	P	P	P	P
spurges	E	P	F	F	P	P	F	G		P	G	F	P	F	P	F	F	P	G
spurweed (burweed)	E	P	P	P	P	P	P			P	E		E	P	P	P	G	P	E
VA buttonweed		P	P	P	P	P				P				P	P	P	P	P	P
violets		P	P	P	P	P				P				P	P	P	P	P	P
white clover	E	P	P	P	P	P				P	G			P	P	P	P	P	G
yellow woodsorrel (<i>Oxalis</i>)	E	P	F-G	F-G	P	F		G		P	G	P	G	F	G	F-G	F	P	P

Key to response symbols: 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.

POSTEMERGENCE CONTROLS (Refer to Herbicide Label for Specific Turf Species and Use Listing)

Comments: Active only on emerged, visible weeds. Best results occur when weeds are young. Temperatures above 85-90° 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.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bermudagrass	MSMA/DSMA/CMA (2.0 lbs) 2,4-D + MCPP + DICAMBA + MSMA	Several brands and formulations Trimec Plus	Crabgrass, crowfootgrass, Bahigrass, nutsedge, Dallisgrass, thin paspalum, alexandergrass, sandspur	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. Do not use on desirable St. Augustinegrass, centipedegrass or Bahiagrass. Use low rates on zoysiagrass.
	MSMA (1.0 lbs) + metribuzin ($\frac{1}{8}$ lbs)	Several brands + Sencor 75DF (0.16 lbs)	Crabgrass, goosegrass, Dallisgrass, nutsedge, thin paspalum	Do not apply to turf under stress. Do not apply to tees, greens, or closely mowed turf. Do not add surfactant with this combination. Do not apply within the root zone of shallow rooted ornamentals. Some degree of short-term phytotoxicity can be expected, especially when applied during hot temperatures.
	metribuzin ($\frac{1}{4}$ lb)	Sencor 75DF ($\frac{1}{3}$ lb)	Goosegrass, some broadleaf weeds	Same as for MSMA + metribuzin above.
	diclofop-methyl ($\frac{3}{4}$ -1 lbs)	Illoxan 3EC (1 to 1.4 qts)	Goosegrass	Do not apply more than one (1) fluid ounce per 1,000 sq. ft. per treatment and not more than a total of 1.5 fluid ounces per 1,000 sq. ft. per year. 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. Treat only well established and actively growing turf. Wait 6 weeks before overseeding after the last application. DO NOT tank mix Illoxan with any other pesticide or liquid fertilizer as reduced goosegrass control may occur. Restricted Use Pesticide.
Bermudagrass	pronamide ($\frac{1}{2}$ lbs)	Kerb 50W (3.0 lbs)	<i>Poa annua</i> , ryegrass clumps	Do not apply on or up-slope to desirable overseeded turf as pronamide may run. Time required for control increases as weeds mature, therefore apply in late fall for optimum results. If applied in spring, 3 to 4 weeks are required for control. Restricted Use Pesticide.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bermudagrass	simazine (1 lb)	Princep Liquid (1 qt)	<i>Poa annua</i> , most annual winter 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. Some yellowing of bermudagrass may result. Do not apply on or up slope to desirable overseeded turf &/or golf greens. Do not use on bermudagrass during spring 'green-up' or summer. Resistance to this herbicide has been noted where continued use without rotation occurs.
	rimsulfuron (0.031 lbs)	TranXit GTA (2 oz)	Ryegrass Removal <i>Poa annua</i>	REMOVAL OF OVERSEED: Apply recommended rate in the spring months 3 to 4 weeks before desired date for overseed removal. <i>POA ANNUA</i> CONTROL: Apply recommended rate within the period of 10 to 14 days prior to overseeding perennial ryegrass and/or <i>Poa trivialis</i> .
Bermudagrass overseeded with Perennial ryegrass	bispyribac-sodium (0.033 - 0.10 lbs)	Velocity (0.66 - 2.0 oz)	<i>Poa annua</i>	Apply two or three times on a 14 to 21 day interval at 1.33 oz/A for control of heavy <i>Poa annua</i> infestations. Use season is January 1 to April 15. Apply to actively growing <i>Poa annua</i> when it first begins to flower. Do not apply when temperatures are below 55 °F.
Tifway (419) Bermudagrass, St. Augustinegrass	MSMA (1.0 lb)	Bueno 6 (1.3 pts) Drexel MSMA	Grass Weeds	USE ONLY ON ST. AUGUSTINEGRASS GROWN FOR SOD PRODUCTION. Temporary discoloration will follow application. Do not apply to freshly mowed St. Augustinegrass sod or within 5 weeks of harvest. Apply when temperatures are <90 F and good soil moisture is present. Do not add a surfactant.
Bahiagrass Bermudagrass Centipedegrass Zoysiagrass	chlorsulfuron (0.05 - 0.25 lbs)	Corsair (1 - 5.33 oz)	Perennial ryegrass White clover Virginia buttonweed Smutgrass Wild garlic	Do not apply near desirable trees. Do not sure on golf greens or tees. Add a nonionic surfactant.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bahigrass Bermudagrass Zoysiagrass Ryegrass	2,4-D Amine (1.0 lb) See product label.	Several Brands	Many broadleaf weeds including matchweed, pennywort, (dollarweed), wild garlic/onion, clover, plantains.	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 as high volatile ester formulations have drift and volatility problems. For hard-to-control perennial broadleaf weeds, formulations containing dicamba will increase control. One-half rate should be used on centipede grass and carpet grass.
	2,4-D + 2,4-DP See product label.			
	dicamba ($\frac{1}{8}$ - $\frac{1}{4}$ lbs) See product label.	Banvel 4S ($\frac{1}{4}$ - $\frac{1}{2}$ pts) plus others	White clover, spurges, woodsorrel, dichondra	Avoid drift. Do not apply within the root zone of ornamentals. 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.
	dicamba ($\frac{1}{8}$ lbs) + 2,4-D, MCP, MCPA, and/or 2,4-DP ($\frac{1}{2}$ - $\frac{3}{4}$ lbs)	Several brands contain these mixtures. See product label for specific rates.	Same as for dicamba, also matchweed, pennywort.	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
	triclopyr (0.28 - 0.56) + clopyralid (0.09 - 0.18)	Confront (1-2 pts)	Black medic White clover Lawn burweed Woodsorrel Virginia buttonweed	Avoid drift. Do not apply to exposed roots of trees or shrubs. Do not use on golf greens.
Centipede grass St. Augustine grass Zoysiagrass	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.	SEE NEW LABEL RESTRICTIONS: For hard to control weeds, make the first application in late winter 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.
	dicamba ($\frac{1}{8}$ to $\frac{1}{4}$ lbs)	Banvel 4S ($\frac{1}{4}$ - $\frac{1}{2}$ pts)	White clover, spurge, woodsorrel	Avoid drift. Do not apply within the root zone of ornamentals. Use low rates on St. Augustine grass. Treat when temperatures are ≤ 80 F to minimize turf damage.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Centipede grass St. Augustine grass Zoysiagrass	dicamba + 2,4-D, 2,4-DP, MCPA, and/or MCPP ($\frac{1}{8}$ + $\frac{1}{4}$ - $\frac{1}{2}$ lbs)	Several brands contain these mixtures	White clover, spurge, woodsorrel, pennywort	Observe same precaution as dicamba above. Refer to product label for rates. A second application on centipede grass 7-14 days later may be needed. Use low rates on St. Augustine grass. 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.
	bromoxynil ($\frac{3}{8}$ to $\frac{1}{2}$ lb)	Buctril 2L (1 to 2 pts)	Many young broadleaf weeds	Labeled only for non-residential turf, seed and sod production. Contact herbicide. Safe on seedling or sprigged turf. 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, and Ryegrass. Restricted Use Pesticide.
Bahia grass Bermudagrass St. Augustine grass Zoysiagrass	bromoxynil ($\frac{1}{4}$ to $\frac{1}{2}$ lb)	Buctril 2L (1 to 2 pts)	Many young broadleaf weeds	Labeled only for non-residential turf, seed and sod production. Safe on seedling or sprigged turf. Tank mixing with 2,4-D, dicamba, &/or MCPP will provide increased control but should be used only on established turf.
	atrazine + bentazon (.83 - 1.5 lbs)	Prompt 5 ($1\frac{1}{3}$ - $2\frac{2}{5}$ pts.)	Many broadleaf weeds including matchweed, oxalis, pennywort, Florida Betony and some sedges	Prompt is intended for the postemergence control of a broad spectrum of broadleaf weeds but does not control grasses. Apply early post-emergence with thorough coverage.
Centipede grass	sethoxydim ($\frac{1}{3}$ lbs)	Vantage 1.0L (2.25 pts)	Crabgrass, goosegrass and other annual grasses	Apply before weeds mature. Repeat applications are necessary to suppress Bermudagrass or Bahia grass. Safe on centipede grass seedlings after the third mowing.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Centipede grass	clethodim (0.125-0.25 lb)	Envoy (17-34 fl. oz.)	Common Bermudagrass control	<p>For use on SOD FARMS ONLY. Do not apply to centipede grass being grown for seed. Do not apply ENVOY Herbicide until 3 weeks after 100% greenup of centipede grass in spring. Two Applications will likely be necessary for control. Second application should not be made until 1-2 inches of new growth of bermudagrass is observed (approximately 3-4 weeks after first application). Use higher labeled rates for more established bermudagrass.</p> <p>Do not treat or allow drift of ENVOY Herbicide onto other turf species, or damage may result. Do not apply ENVOY Herbicide if rainfall is expected within one hour after application. Avoid mowing sod for one week before and after application. At rates above 17 oz./A, ENVOY Herbicide can cause temporary centipede grass injury when tank-mixed with crop oil concentrate.</p>
Bahia grass Bermudagrass	hexazinone (2 to 6 lbs)	Velpar 2L (1 to 3 gal)	Smutgrass, some broadleaf weeds	Labeled only for non-cropland turf such as roadsides, railroads, industrial sites, and underneath utility lines. Soil moisture must be present for herbicide activity. Best control and least turf damage follows late winter application. Do not apply after April. Temporary turf discoloration can be expected following treatment, especially to Bahia grass. Do not use underneath desirable shrubs or trees. Read and follow all label directions before use.
	sulfometuron (0.05 to 0.19 lb)	Oust 75DG (1 to 2 oz)	Fescue, Broadleaf weeds	Highway roadside use only. Use in spring (1 to 3 oz/a) 30 days after green-up or 1 to 2 weeks after mowing. Also used in late fall to early winter (1 to 4 oz/a). Often tank-mixed with MSMA (3 to 4 lbs ai/a) for broader spectrum of weed control in bermudagrass.
	sulfosulfuron (0.5 to 1.5 oz)	Outrider (3/4 to 2 oz)	Johnsongrass Purple Nutsedge Yellow Nutsedge Horseweed Vaseygrass Chickweed	Highway roadside use only.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
St. Augustinegrass	ethofumesate (3.0 lb)	Prograss 1.5EC (2 gal)	Common Bermudagrass control or suppression	Timing is critical. Spring applications should start in late Feb. (South FL) or early (central FL) to mid (North FL and Northward) March. Repeat in 30 days. Tank mixing with atrazine or simazine at 2 lb ai/A significantly increases suppression. For repeat applications, reduce atrazine or simazine to 1 lb ai/a. Temporary St. Augustinegrass stunting may result. Do not overlap.
Zoysiagrass	fenoxaprop (0.12 to 0.35 lb)	Acclaim 1EC (15 to 45 oz)	Annual grass weeds, Bermudagrass suppression	Young, actively growing weeds are easiest to control. Do not apply to moisture- or heat-stressed turf. Repeat application in 2 to 3 weeks may be required for complete control. Do not mow for at least 24 hrs after application.
	fluazifop (0.047 to 0.078 lbs)	Fusilade II (2EC) (3 to 4 oz)	Annual grasses Common Bermudagrass Suppression	Add nonionic surfactant. Repeat application in 4 weeks. Minor, short-term turf phytotoxicity may occur, especially when applied during hot, dry weather.
Bermudagrass (Common & Hybrid) Zoysiagrass	carfentrazone + MCPA + MCPP + dicamba	Power Zone (2 - 4 pts)l	Broadleaf weeds (see label)	Carfentrazone combinations are fast-acting often exhibiting evidence of activity within hours.
	carfentrazone + 2,4-D + MCPP + dicamba	Speed Zone (2 - 4 pts)	Broadleaf weeds (see label)	Carfentrazone combinations are fast-acting often exhibiting evidence of activity within hours.
	foramsulfuron (0.013 to 0.026 lbs)	Revolver (8.8 - 17.4 oz)	Ryegrass Removal <i>Poa annua</i> Goosegrass	Apply when bermudagrass has resumed active growth and removal of ryegrass is desirable. Speed of ryegrass removal depends on temperature (above 70 F, removal can occur in 1 week).
	quinclorac (.5 - .75 lbs)	Drive 75DF (.67 - 1.0 lbs)	Torpedograss Crabgrass	For best torpedograss control, make split applications at 21 day intervals. Goosegrass is not effectively controlled with Drive 75DF.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bermudagrass (Common & Hybrid) Zoysiagrass	trifloxysulfuron 0.00469 - 0.02	Monument 75WG 0.1 to 0.53 oz	<i>Poa annua</i> Perennial ryegrass Nutsedge and Kyllinga Broadleaf weeds (see label)	0.1 to 0.35 oz/Ac for perennial ryegrass and <i>Poa trivialis</i> removal. 0.35 to 0.53 oz/Ac to control <i>Poa annua</i> , purple and yellow nutsedge, various broadleaf weeds in established turf. Use rate of 0.53 oz/Ac for broadleaf signalgrass and suppression of torpedograss, Virginia buttonweed (seedlings), bahiagrass, dallisgrass, and crabgrass. Buffer water to pH 7 or less. Speed of ryegrass/ <i>Poa annua</i> removal depends on temperature. Allow at least 3 weeks between last application and overseeding with cool season grasses for winter cover. Weed death may take 2 to 4 weeks or more under cool conditions. Lightly irrigate 4 hours or more after application to minimize tracking and movement if applications are made next to non- labeled cool-season turfgrass species. Golf course and non-residential use only. Multiple applications needed for hard-to-control weeds.
Centipedegrass St. Augustinegrass Seashore Paspalum Zoysiagrass Bermudagrass Bahiagrass Perennial Ryegrass	clopyralid (0.1 - 0.25 lbs)	Lontrel T & O (1/4 - 2/3 pt)	Broadleaf weeds including black medic, clover, and plantain.	Maximum use rate in Florida is 2/3 pt. per acre per growing season. Clopyralid containing products may NOT be used on residential turf.
	fluroxypyr (0.125 - 0.25 lbs)	Spotlight (0.66 - 1.3 pts)	Clover and other broadleaf weeds (see label).	DO NOT APPLY TO ST. AUGUSTINEGRASS IN FLORIDA. Approved tank mixtures provide improved weed control spectrum (see label). Use low rates on bermudagrass as a spot treatment.
	carfentrazone + 2,4-D + MCPP + dicamba	Speed Zone - Southern (1.5 - 4 pts)	Broadleaf Weeds (see label)	Carfentrazone combinations are fast-acting exhibiting evidence of activity within hours. Do Not Apply to 'Floritam' or 'Bitterblue' varieties. Do Not Apply to St. Augustinegrass under shade, disease and/or moisture stress. During higher temperatures, lower rates are recommended.

GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	metsulfuron (0.0156 - 0.0625 lbs.)	Manor (0.25 - 1.0 oz) Blade (0.25 - 1.0 oz)	Safely removes unwanted bahiagrass from desirable turf species. Selected broadleaves.	Do not expect to see results for two to three weeks after application. Will require repeat application(s).
Centipedegrass St. Augustinegrass Seashore paspalum Zoysiagrass Bermudagrass (common and hybrid) Bahigrass	carfentrazone-ethyl (0.008 - 0.031 lbs)	QuickSilver (0.9 - 2.1 fl oz) Aim (sod production)	Annual and perennial broadleaf weeds (see label for complete list).	Use as a stand-alone product for control of seedling broadleaf annual weeds or with other pre- and postemergence herbicides for control of annual and perennial broadleaf weeds. Some temporary discoloration may occur 3 to 7 days after application. Rapidly absorbed by weeds with symptoms often visible within 24 hours of application.
Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	sulfosulfuron (0.35 - 0.59 lbs)	Certainty (0.75 - 1.25 oz)	Nutsedge and kyllinga species <i>Poa annua</i>	A second application of 0.75 to 1.25 oz./acre may be made 4 to 10 weeks after initial treatment, if needed. Some chlorosis or stunting of the desirable turf may occur following application. Use of a nonionic surfactant is required. Certainty may be used for control of <i>Poa annua</i> prior to overseeding of perennial ryegrass.

Postemergence Herbicide Efficacy Ratings

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

	Lifecycle	atrazine	bentazon	bispyribac-sodium	bromoxynil	carfentrazone	clethodim	clopyralid	2,4-D	2,4-D + dicamba	dicamba	diclofop	ethofumesate	fenoxaprop	fluzifop	fluroxypyr	foramsulfuron	glufosinate	glyphosate	hexazinone
GRASS and "GRASS-LIKE" WEEDS																				
bahiagrass	P	P	P		P	P	F	P	P	P	P	P	F	P	F	P	P	P	G	P
bermudagrass	P	P	P		P	P	F-G	P	P	P	P	P		P	G	P	P	P	E	P
dallisgrass	P	P	P		P	P	F	P	P	P	P	P		P		P	P	P	E	
nutsedge, purple	P	P	P		P	P	P	P	F	P	P	P		P	P	P	P	P	G	
nutsedge, yellow	P	P	G		P	P	P	P	F	P	P	P		P	P	P	P	P	E	
torpedograss	P					P		P							P	P	P	F		
wild garlic/onion	P	P	P		P	P	P	P	G	G	F	P		P	P	P	P	P	G	
ANNUAL GRASSES																				
<i>Poa annua</i>	WA	E	P	G	P	P	F	P	P	P	P	P	G	P	P	P	E	E	E	
crabgrass	SA	F	P		P	P	E	P	P	P	P	P	F	G-E	G	P	P	E	E	
crowfootgrass	SA	P	P		P	P	E	P	P	P	P			G-E	G	P	P	E	E	
goosegrass	SA	P	P		P	P	F-G	P	P	P	P	E		G	G	P	G	E	E	
sandbur	SA	P	P		P	P	G	P	P	P	P			G-E	G	P	P	E	E	
BROADLEAF WEEDS																				
bittercress, hairy	WA						P	F		E	E	P		P	P		P			
black medic	A					G	P	E	E	P	E	P		P	P	F	P			
buttercups	WA,B,P	F	P		P	G	P	F-P	E-F	E-F	E-F	P		P	P		P			
carpetweed	SA	E					P		E	E	E	P		P	P		P			
carrot, wild	A,B						P	F	F	E-F	E	P		P	P		P			
catsear dandelion	P						P	E	E-F	E-F	E	P		P	P	F	P			
chamberbitter (niruri)	SA,P	G	P				P	P	P	P-F	P-F	P		P	P		P		E	
common chickweed	WA	E	G		P		P	E-F	P	G	E	P		P	P	F	P	G	E	
corn speedwell	WA	E	P		G		P	P	F	F	F	P		P	P	P	P		E	
cudweed		G			G	F	P	E	G-E	E	E	P		P	P	F	P		G	
dandelion	P	F	P		P		P	F	E	G	E	P		P	P	F	P		E	
dayflower, spreading	SA	G-E	G				P		F	F	F	P		P	P		P			
dichondra	P	E	P		P	F	P		G	G	G	P		P	P		P		E	

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	Lifecycle	atrazine	bentazon	bispyribac-sodium	bromoxynil	carfentrazone	clethodim	clopyralid	2,4-D	2,4-D + dicamba	dicamba	diclofop	ethofumesate	fenoxaprop	fluzifop	fluroxypyr	foramsulfuron	glufosinate	glyphosate	hexazinone
docks	P	G	P			G	P	E	F	G	E	P		P	P		P	G	E	
doveweed	SA	G-E	P		P		P		P	F	P	P		P	P	P	P		G	
Florida betony	P	F-G	P		P	P	P		F	G	G	P		P	P	F	P		E	
geranium, carolina	WA	E				G	P	P	E	E	E	P		P	P	P	P			
ground ivy	P		P		P		P		P-F	F	G	P		P	P	P	P		G	
hawkweed	P					G	P		E-F	E-F	E-F	P		P	P		P			
henbit	WA	E	P		G	G	P		P	G	E	P		P	P	G	G		E	
hop clovers	WA	E			F	G	P	E	F	G	E	P		P	P	G	P	G	E	
knawel	WA						P		P	E-F	E	P		P	P		P			
knotweed	SA	E			F		P	E	P	G	E	P		P	P		P		E	
lespedeza	SA	E					P	P	P-F	G	E	P		P	P	F	P		E	G
mallow	P	P	P				P		F	F-G	E	P		P	P		P			
mock strawberry	P	P	P				P		P	G	G	P		P	P		P	G		
mouseear chickweed	WA,P	G	P			G	P	F	P-F	G	E	P		P	P	F	P	G	E	
mugwort	P	P	P				P		F	F	G	P		P	P		P		G	
mustards	WA	E	G		G		P	P	E	G	E	P		P	P		P		E	
parsley piert	WA	E	G		G		P		P		E	P		P	P	F	P		E	
pearlwort	WA						P	P	E-F			P		P	P		P			
pennywort (dollarweed)	P	E	P		P	P	P	F	G	G	E	P		P	P	F	P		E	
pepperweed, VA	WA	E			F	G	P		E	E	E	P		P	P	P	P			G
pigweed	WA	G	P		F-G	G	P		E	E	E	P		P	P		P	G		G
plantains	P	F	P		P		P	F	E	G	F	P		P	P		P		E	
shepherdspurse	WA		G		G		P	F	E	E	E	P		P	P		P			
spurges	SA	E	P		F	G	P	F	F	G	G	P		P	P	F	P		E	
spurweed (burweed)	WA	E	E		G		P	E	G	G	E	P		P	P	F	P		E	
thistles	B,P	P					P	E	E-F	E-F	E-F	P		P	P		P			
VA buttonweed	P	P	P		P	G	P	F-P	P	F	F	P		P	P	F	P		G	
violets	P	P	P			G	P		P	F	F	P		P	P	P	P			

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	Lifecycle	atrazine	bentazon	bispyribac-sodium	bromoxynil	carfentrazone	clethodim	clopyralid	2,4-D	2,4-D + dicamba	dicamba	diclofop	ethofumesate	fenoxaprop	fluzifop	fluroxypyr	foramsulfuron	glufosinate	glyphosate	hexazinone
white clover	P	E	P			G	P	E	F	G	E	P	F	P	P	E	P	G	F	
yellow woodsorrel (<i>Oxalis</i>)	P	G	P		F	G	P	F-P	P	F	G	P		P	P	F	P	G	E	G

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	Lifecycle	imazaquin	metribuzin	met sulfuron	MSMA/DSMA	pronamide	quinclorac	rimsulfuron	sethoxydim	simazine	sulfometuron	sulfosulfuron	triclopyr + clopyralid	trifloxysulfuron
GRASS and "GRASS-LIKE" WEEDS														
bahiagrass	P	P	P	E	F	P	P		F	P		F	P	F
bermudagrass	P	P	P	P	P	P	P		F	P		P	P	P
dallisgrass	P	P	P	P	G	P	F		P	P			P	F
nutsedge, purple	P	G	P	P	F	P	P		P	P	E	E	P	E
nutsedge, yellow	P	F-G	P	P	F	P	P		P	P	E	E	P	E
torpedograss	P						E		P	P			P	G
wild garlic/onion	P	E	P	E	P	P			P	P			P	
ANNUAL GRASSES														
<i>Poa annua</i>	WA	P-F	E	P	P	E	P	G	P	E	G	G	P	G
crabgrass	SA	P	F	P	E	P	E		E	P			P	F
crowfootgrass	SA	P	G	P	E	P			F-G	P			P	
goosegrass	SA	P	G	P	F	P	P		G	P			P	
sandbur	SA	F	G	P	G	P			G	P			P	

Postemergence Herbicide Efficacy Ratings

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	Lifecycle	imazaquin	metribuzin	met sulfuron	MSMA/DSMA	pronamide	quinclorac	rimsulfuron	sethoxydim	simazine	sulfometuron	sulfosulfuron	triclopyr + clopyralid	trifloxysulfuron
BROADLEAF WEEDS														
bittercress, hairy	WA		G	E					P				E	
black medic	A						E		P				E	
buttercups	WA,B,P	G		E					P	F		G	E	
carpetweed	SA			P					P	G				G
carrot, wild	A,B			E					P					
catsear dandelion	P								P				E	
chamberbitter (niruri)	SA,P	P			P-F				P	F				
common chickweed	WA	E	G	E	P	G		F	P	E	G		E	
corn speedwell	WA	P	E	E	P	G			P	E			P	
cudweed		F			F-G				P	G			G-E	
dandelion	P			E	P	P			P	P			E-F	G
dayflower, spreading	SA	G		P-F			P		P	G				
dichondra	P				P	P			P	P			E	G
docks	P			E	P	P			P	P			E	
doveweed	SA		F	P		P			P	F			P	
Florida betony	P				P	P			P	P			G	
geranium, carolina	WA	G		F-G					P	G			F	
ground ivy	P				P	P			P	P			E-F	
hawkweed	P								P				E	
henbit	WA	G	G	G	P	P		F	P	E		G	E	G
hop clovers	WA		G	P-F	P				P	E			E	G
knawel	WA	G							P					
knotweed	SA		G		P				P	G			E	
lespedeza	SA		E	E	P				P	G			E	
mallow	P				P	P			P	P			E	

Postemergence Herbicide Efficacy Ratings

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	Lifecycle	imazaquin	metribuzin	metsulfuron	MSMA/DSMA	pronamide	quinclorac	rimsulfuron	sethoxydim	simazine	sulfometuron	sulfosulfuron	triclopyr + clopyralid	trifloxysulfuron
mock strawberry	P				P	P			P	P				
mouseear chickweed	WA,P	G	E	E	P	P			P	P		G	E	
mugwort	P				P	P			P	P				
mustards	WA		F	F	P	P			P	G		G		
parsley piert	WA	G	E		P	P			P	E			G	
pearlwort	WA								P					
pennywort (dollarweed)	P			G	P	P	E	F	P	P			E	
pepperweed, VA	WA								P	G				
pigweed	WA			E-G					P	F				
plantains	P			G	P	P			P	P			E	
shepherdspurse	WA			G					P		G	G	E-F	
spurges	SA		E	E	P			F	P	G			E-F	G
spurweed (burweed)	WA	E	G	E	P	P			P	E			E	
thistles	B,P	G		F					P	P			E	
VA buttonweed	P				P	P			P	P			F	G
violets	P				P	P			P	P			F-G	
white clover	P	F	F	E	P	P			P	P		G	E	G
yellow woodsorrel (<i>Oxalis</i>)	P			F-G	G	P			P	P			F-G	G

SEDGES	
Leaves composed of a blade, a sheath, and a ligule. Leaf sheath is closed. Ligule is often absent, when present is tiny. Stem is often triangular.	
Yellow Nutsedge, <i>Cyperus esculentus</i>	Perennial; underground runners; runners stop at tubers; tubers sweet to taste or with little flavor; seedhead yellow. Leaf tip needle-shaped.
Purple Nutsedge, <i>Cyperus rotundus</i>	Perennial; underground runners that continue from tuber to tuber, forming chains; tubers bitter to taste; seedhead purple or reddish. Leaf tip boat-shaped.
Globe Sedge, <i>Cyperus globulosus</i>	Perennial; forming clump; shiny green leaves; base hard; seedheads like small globes. Cylindric Sedge just as common; has all the same characteristics as the above differing only in the seedhead which is shaped like a cylinder with smaller and finer flowers.
Perennial (Green) Kyllinga <i>Cyperus brevifolius</i>	Mat forming perennial from reddish purple rhizomes. Leaves and stems, dark green. Seedhead simple, nearly round or oblong, with three short leaves just below. Reproduces by seed and rhizomes. Found in low areas or where moisture is excessive.
Annual Sedge <i>Cyperus compressus</i>	Annual; spreads by seed formed from clusters of flat spikes. Spikes greenish, sometimes glossy, up to 1-inch long.

SEDGE CONTROL				
GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bermudagrass	imazaquin + MSMA/DSMA ($\frac{3}{8}$ + 1-2 lbs/4.0 lbs)	Image 70DG (8.6 - 11.4 oz) + Several Brands	Many sedges	Repeat applications may be required as weeds mature.
Bermudagrass Zoysiagrass	MSMA/DMSA (2.0 lbs/4.0 lbs)	Several brands	Yellow nutsedge, annual (water) sedge	Repeat application will be needed 10 to 14 days apart. Use a wetting agent. Some turf discoloration can be expected.
	2,4-D + MCPP + DICAMBA + MSMA	Trimec Plus		
	trifloxysulfuron 0.00469 - 0.02	Monument 75WG (0.1 to 0.53 oz)	Purple and Yellow Nutsedge Green Kyllinga	0.33 to 0.53 oz/Ac for purple and yellow nutsedge and Kyllinga. Buffer water to pH 7 or less. Weed death may take 2 to 4 weeks or more under cool conditions. Lightly irrigate 4 hours or more after application to minimize tracking/movement if applications are made next to non-labeled cool-season turfgrass species. Golf course and non-residential use only. Multiple applications needed for hard-to-control weeds.
Bahiagrass Bermudagrass Centipedegrass St. Augustinegrass	bentazon (1-2 lb)	Basagran T&O 4L (2-4 pts) Lescogran 4L (2-4 pts)	Yellow nutsedge, globe sedge, annual sedge and some broadleaf weeds	Apply when yellow nutsedge is actively growing under good soil moisture conditions. Repeat applications will probably be necessary. Will not satisfactory control purple nutsedge. Not labeled for golf greens. A pre-packaged combination of bentazon and atrazine is available as Prompt.

SEDGE CONTROL				
GRASS	COMMON NAME (lbs ai/acre)	TRADE NAME (product rate/acre)	WEEDS CONTROLLED	COMMENTS
Bahigrass Bermudagrass Centipedegrass St. Augustinegrass	halosulfuron (0.03 to 0.06 lb)	Manage 75WP (0.67 to 1.33 oz)	Most nutsedges	Note the low use rate. Nutsedges should be actively growing when treated. Repeat application(s) 3 to 4 weeks apart will be needed for complete control. Now labeled for 4 applications per year with a maximum use rate of 5.33 oz product/acre/year.
	imazaquin ($\frac{3}{8}$ - $\frac{1}{2}$ lb)	Image 70DG (8.6-11.4 oz)	Purple nutsedge, sandspur, wild garlic, some broadleaves	Do not apply to newly seeded, sodded, sprigged areas. Apply only to actively growing turfgrass. Not labeled for use on Bahigrass or golf greens. Repeat applications may be required as weeds mature. Treated turf may have a compacted growth habit and seedhead formation may be inhibited. Do not use on overseeded turf.
	Sulfosulfuron	Certainty (0.75 - 1.25 oz)	Nutsedge and Kyllinga	A second application of 0.75 to 1.25 oz./acre may be made 4 to 10 weeks after initial treatment, if needed. Some chlorosis or stunting of the desirable turf may occur following application. Use of a nonionic surfactant is required.
Bahigrass Bermudagrass Centipedegrass St. Augustinegrass Zoysiagrass	S-metolachlor (1.1 - 2.2 lbs)	Pennant Magnum 7.62L (1.3 to 2.6 pts)	Preemergence Control of yellow nutsedge and annual sedge	For use on golf course fairways, 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 4.2 pts./A/yr. Tank mixing with atrazine will increase the weed control spectrum. Do not use Pennant Magnum on golf greens, tees, or aprons or within 4 months of overseeding. Irrigate within 7 days after application.
Seashore paspalum	bentazon (1-2 lb)	Basagran T&O 4L (2-4 pts) Lescogran 4L (2-4 pts)	Yellow nutsedge, globe sedge, annual sedge and some broadleaf weeds	Apply when yellow nutsedge is actively growing under good soil moisture conditions. Repeat applications will probably be necessary. Will not satisfactory control purple nutsedge. Not labeled for golf greens.
	halosulfuron (0.03 to 0.06 lb)	Sedgehammer 75WG (0.67 to 1.33 oz) Sanda 75WG (Sod production)	Most nutsedges	Nutsedge should be actively growing when treated. A second treatment, if needed, may be made 6 - 10 weeks after the initial treatment. Use a non-ionic surfactant.
	imazaquin ($\frac{3}{8}$ - $\frac{1}{2}$ lb)	Image 70DG (8.6-11.4 oz)	Purple nutsedge	Do not apply to newly seeded, sodded, sprigged areas. Apply only to actively growing turfgrass.

Sedge control and turf tolerance to various herbicides (Refer to Herbicide Label for Specific Species Listing).

Herbicide(s)*	Nutsedge Control				Turf Tolerance							
	Purple	Yellow	Annual	Kyllinga	Bermuda	Carpetgrass	St.Augustine	Bahiagrass	Centipede	Zoysia	Seashore Paspalum	Overseed Ryegrass/ Blends
Basagran	P	G	G	F-G	S	S	S	S	S	S	S	S-I
Certainty	E	E	E	E	S	NR	S	NR	S	S	NR	D
Image	G	G	G	G	I	I	S	D	S	S	S	D
Sedgehammer/Sandea	G	G	G	G	S	--	S	S	S	S	S	--
Monument	E	E	E	E	S	NR	NR	NR	NR	S	NR	D
MSMA/DSMA	F	F	F-G	F	S-I	D	D	D	D	I	NR	D
Image + MSMA/DSMA	G	G	G	G	I	I	D	D	D	S	NR	D
Trimec Plus	P	G	G	F	S-I	D	D	D	D	S-I	NR	D

S=Safe at labeled rates; I=Intermediate safety, use at reduced rates; D=Damaging, do not use; NR=Not Registered for use on this turfgrass. G=good; F=fair; P=poor.

*Repeat applications are necessary for complete control from all herbicides.

Turfgrass Tolerance to Postemergence Herbicides (Refer to Herbicide Label for Specific Species Listing) ¹								
Herbicide	Bahiagrass	Bermudagrass	Carpetgrass ²	Centipede	Seashore paspalum	St. Augustine	Zoysiagrass	Overseed Rye/ Blends
atrazine (Aatrex)	NR	NR	I	S-I	NR	S-I	I	D
bentazon (Basagran)	S	S	S	S	S	S	S	S-I
bispyrabac-sodium (Velocity)	NR	S ³	NR	NR	NR	NR	NR	S
bromoxynil (Buctril)	S	S	S	S	NR	S	S	S
carfentrazone (Quicksilver)	S	S	NR	S	S	S	S	S
chlorsulfuron (Corsair)	I	I	NR	NR	NR	NR	NR	NR
clopyralid (Lontrel)	S	S	NR	S	S	S	S	S
2,4-D	S	S	I	I	NR	I	S	S-I
2,4-D+dicamba	S	S	I	I	NR	I	S	S-I
2,4-D+2,4-DP	S	S	I	I	NR	I	S	I-D
2,4-D+MCPP	S	S	I	I	NR	I	S	I-D
2,4-D+MCPP+dicamba	S	S	I	I	NR	I	S	I-D
2,4-D+MCPP+2,4-DP	S	S	I	I	NR	I	S	I-D
2,4-D+MCPP+dicamba+MSMA	D	S-I	D	D	NR	D	S-I	D
2,4-D+clopyralid+dicamba	S	S	I	I	NR	S-I	S	S
dicamba (Banvel)	S	S	I	I	NR	I	S	I
diclofop (Illoxan)	NR	S	NR	NR	NR	NR	NR	NR
DSMA,MSMA	D	S	D	D	NR	D	I	D
ethofumesate (Prograss)	NR	D	--	NR	NR	I	NR	D
fenoxaprop (Acclaim)	I-D	I-D	D	D	NR	D	I	I
fluazifop (Fusilade)	NR	NR	NR	NR	NR	NR	S	NR
fluroxypyr (Spotlight)	S	I	NR	S	NR	D	S	S
foramsulfuron (Revolver)	NR	S	NR	D	NR	NR	S	D
hexazinone (Velpar)	I	I-S	NR	NR	NR	NR	NR	D
MCPA+MCPP+2,4-DP	S	S	I	I	NR	I	I	I-D
MCPP	S	S	I	I	NR	I	S	I
metribuzin (Sencor)	D	S-I	D	D	NR	D	NR	D
metsulfuron (Escort, Manor)	D	S	I	S	NR	S-I	S	D
pronamide (Kerb)	NR	S	NR	NR	NR	NR	NR	D
quinclorac (Drive)	D	I-S	--	D	S	D	S	S
rimsulfuron (TranXit GTA)	NR	S	NR	NR	NR	NR	NR	NR
sethoxydim (Vantage)	D	D	D	S	NR	D	D	D
simazine	NR	I	--	S	NR	S	S-I	D
sulfometuron (Oust)	I	I	NR	NR	NR	NR	NR	NR
sulfosulfuron (Certainty)	NR	S	NR	S	NR	S	S	D
triclopyr + clopyralid	I	I	NR	I	NR	D	I	S
trifloxysulfuron (Monument)	NR	S	NR	NR	NR	NR	S	D

¹S=Safe at labeled rates; I=Intermediate safety, use at reduced rates; D=Damaging, do not use; NR=Not Registered for use on this turfgrass.

²Carpetgrass tolerance to herbicides listed has not fully been explored.

³Safe when applied to overseeded bermudagrass January 1 to April 15.

Presence of a herbicide in this listing does not constitute a recommendation. Trade names are used with the understanding that no endorsement is intended or no criticism is implied of similar products not mentioned. All chemicals should be used in accordance with the manufacturer's instructions.

Common and Trade Names of Turf Herbicides.

Common Name	Manufacturer / Distributor	Trade Name(s)
Atrazine	Syngenta, Ortho, Security, + others	Aatrex, Atrazine Plus, Purge II, + others
Benefin	Dow AgroSciences + others	Balan, Crabgrass Preventer, + others
Benefin & oryzalin	Dow AgroSciences	XL 2G
Benefin & oxadiazon	Regal Chemical	RegalStar
Benefin & trifluralin	Verdicon / UHS	Team 2G
Bensulide	Gowan, Scotts, + others	Betasan, Pre-San, Bensumec 4, Weedgrass Preventer, + others
Bentazon	TopPro Specialties, LESCO	Basagran T&O, Lescogran 4L
Bentazon & Atrazine	TopPro Specialties	Prompt
Bispyrabac	Valent USA	Velocity
Bromoxynil	Bayer	Buctril 2L
Carfentrazone	FMC	Quicksilver/Aim
Carfentrazone + 2,4-D + MCPP + Dicamba	PBI/Gordon	SpeedZone, SpeedZone - Southern
Carfentrazone + MCPA + MCPP + Dicamba	PBI/Gordon	Power Zone
Clethodim	Valent USA Corp.	Envoy
Clopyralid	Dow AgroSciences	Lontrel T&O
2,4-D	Bayer, Riverdale, + others	Many
2,4-D+Clopyralid + Dicamba	Riverdale	Millennium Ultra 2
DCPA	Syngenta	Dacthal 75WP, Garden Weed Preventer, + others
Dicamba	Syngenta, Scotts, + others	Vanquish 4L, K-O-G Weed Control, + others
Diclofop	Bayer	Illoxan 3EC
Dithiopyr	Dow AgroSciences	Dimension Ultra
Diquat	Syngenta	Reward LS
DSMA	Syngenta	Ansar 6.6
Ethofumesate	Bayer	Prograss 1.5L
Fenoxaprop	Bayer	Acclaim

Common Name	Manufacturer / Distributor	Trade Name(s)
Fluazifop	Syngenta	Fusilade II
Fluroxypyr	Dow AgroSciences	Spotlight
Foramsulfuron	Bayer	Revolver
Glufosinate	Bayer	Finale 1L
Glyphosate	Monsanto, Syngenta, + others	RoundUp, Touchdown PRO, Glyphomaxx
Halosulfuron	Gowan	Sedgehammer 75DG / Sandea 75DG
Hexazinone	DuPont	Velpar 2L
Imazaquin	BASF	Image 70DG
Isoxaben	Dow AgroSciences	Gallery 75DF
MCPP	PBI/Gordon, Ortho, + others	Mecomec 4
MCPP, 2,4-D + dicamba + MCPA and/or 2,4-D	PBI/Gordon, LESCO, Riverdale, Sierra,	Trimec Southern/3-Way Selective/Eliminate DG/33, others
Metribuzin	Bayer	Sencor 75DF
Metolachlor	Syngenta	Pennant Magnum
Metsulfuron	Riverdale	Manor
MSMA	Syngenta	Daconate 6, Bueno 6, others
Napropamide	United Phosphorus, UHS	Devrinol 50DF, Ornamental Herbicide 2G
Oryzalin	UPI	Surflan AS
Oxadiazon	Bayer	Ronstar 2G, 50WP
Pendimethalin	LESCO, BASF, Scotts	Pre-M, Pendulum, Southern Weedgrass
Prodiamine	Syngenta / NuFarm	Barricade 65WG, 4FL / ProClipse
Pronamide	Dow AgroSciences	Kerb 50WP
Quinclorac	BASF	Drive
Rimsulfuron	DuPont	TranXit GTA
Sethoxydim	TopPro Specialties	Vantage
Simazine	Syngenta + others	Princep Liquid, others
Sulfentrazone + 2,4-D + MCPP + Dicamba	PBI Gordon	Surge Broadleaf Herbicide

Common Name	Manufacturer / Distributor	Trade Name(s)
Sulfometuron	DuPont	Oust
Sulfosulfuron	Monsanto	Certainty
Triclopyr + clopyralid	Dow AgroSciences	Confront
Trifloxysulfuron	Syngenta	Monument

Plant Growth Retardants for Fine Turf and Roadsides/Utilities

J. Bryan Unruh and Barry J. Brecke

Extension Turfgrass Specialist and Research Weed Scientist

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.) 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 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 plants. 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 fluazifop.

Type II inhibitors are generally root absorbed and suppress growth through interference of gibberellic acid bio-synthesis, a hormone responsible for cell elongation. Type II PGRs are slower in growth suppression response, but their duration is usually from 4 to 7 weeks, again, depending on application rate. Type II PGRs have little effect on seedhead development and results 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 *Poa annua* on putting greens.

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 these and weeds present down. 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.

Chemicals for Seedhead and Plant Growth Suppression

Chemical (Trade Names)	Active Ingredient per Acre	Amount of Product Per Acre	Remarks
<i>Poa annua</i> Seedhead Suppression			
ethophon (CHIPCO Proxy)	3.4 lb	1.7 gal / 21-174 gal water	Ethophon is a Type II plant growth regulator available for use for seedhead suppression on <i>Poa annua</i> and white clover.
Low Maintenance Bahiagrass			
sulfometuron-methyl (Oust 75 DG)	0.02 lb	½ oz/30-50 gal water	Foliar absorbed. Apply to bahiagrass in spring or 7 to 14 days after first mowing. Do not use a surfactant. Do not apply to wetlands or where runoff water may drain onto cultivated lands or forests. Do not apply to turf less than 3 years old. Treated areas may appear less dense and temporarily discolored. Read and follow all label recommendations before use. Often tank-mixed with Roundup, Campaign and/or Velpar. DO NOT EXCEED RECOMMENDED RATE.
maleic hydrazide (Retard 2¼ lb/gal, Royal Slo-Gro 1½ lb/gal, Liquid Growth Retardant 0.6 lb/gal)	3.0 lb	1⅓ gal/50 gal water 2 gal/30-50 gal water 5 gal/45 gal water	Foliar absorbed. Apply to bahiagrass in spring or 7 to 14 days after first mowing. Do not use a surfactant. Do not apply to turf less than 3 years old and do not reseed within 3 days after application. Treated areas may appear less dense and temporarily discolored. Do not use on St. Augustinegrass, and do not apply to bahiagrass under drought conditions. Read and follow all label recommendations before use. A 12-hour rainfree period is required for optimum activity.
glyphosate (Roundup 4 lb/gal) glyphosate + 2,4-D (Campaign 2.5L) Touchdown Pro	0.18-0.22 lb	4 to 8 fl oz/10-25 gal water 16 to 24 oz/A	Foliar absorbed. Apply to bahiagrass only. 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 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.

Chemical (Trade Names)	Active Ingredient per Acre	Amount of Product Per Acre	Remarks
Bermudagrass and St. Augustinegrass			
mefluidide (Embark 2S) (Embark Turf and Ornamental Growth Regulator)	0.125 to 1.0 0.125	½ to 4 pts/15-150 gal water 5 pts (St. Augustinegrass)	Foliar absorbed. Apply to common bermudagrass (4 pts/A Embark 2S) and St. Augustinegrass (Embark T&O) only. Apply in spring approximately 2 weeks before seedhead appearance. 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 (Cutless 50 WP)	0.25 to 1.5 lbs	0.5 to 3.0 lb	Root absorbed. Apply to bermudagrass or zoysiagrass golf course fairways, hard-to-mow and trimmed areas. Provides 4 to 8 week suppression. Must be uniformly applied and irrigated in with ½ inch water. Flurprimidol does not completely control seedheads. Temporary turf discoloration may follow this treatment. St. Augustinegrass, bahiagrass, and common bermudagrass require the higher rate. Repeat applications every 4 weeks on Tifway bermudagrass with 0.5 lb/A will minimize turf injury. Good growth regulation and turf enhancement have been noted with half-rates of the Cutless + PrimoMAXX tank mix. Not recommended for bermudagrass golf greens.
trinexapac-ethyl (Primo MAXX)	0.1 to 0.75	9 to 88 oz / A	Foliar absorbed. Low rates are for hybrid bermudagrass, centipedegrass, and St. Augustinegrass; medium rates are for common bermuda while the high rate is for bahiagrass and for edging and banding of bermudagrass and St. Augustinegrass. One hour rain-free period is needed after application. Mowing one week after application improves results and appearance as will repeat applications in two to four weeks. Do not exceed 21 pints/A per year (WSB = 174 fl. oz/A/year). Seedhead suppression is provided only for hybrid bermudagrass. Temporary turf discoloration may follow treatment. Do not add a surfactant.
Trinexapac-ethyl + 5-0-10 fertilizer (Governor)	0.02 to 0.44 lbs	36 to 720 lbs / Ac	A granular formulation of trinexapac-ethyl for professional use, which could also be purchased for homeowner use. This warm-season-turf formulation works to reduce clippings and mowing frequency like the sprayable product.
paclobutrazol (TGR Turf Enhancer 50WP) Turf Growth Regulator + fertilizer 0.82% Trimmit 2SC	½ to 1 0.6 to 0.9 lb 0.5 to 0.75 lb	1 to 1½ lb/43 to 100 gal water 73 to 110 lb 32 to 48 oz	Root absorbed. Apply to well-maintained St. Augustinegrass or hybrid bermudagrass fairways. Do not apply to bermudagrass greens. 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.

Chemical (Trade Names)	Active Ingredient per Acre	Amount of Product Per Acre	Remarks
Foliar Suppression of Overseeded Bermudagrass			
trinexapac-ethyl (Primo MAXX)	0.1 to 0.75	0.75 to 6 pints/20 to 100 gal water	Apply trinexapac-ethyl before verticutting, scalping, spiking, or other similar operations or 1 to 5 days before seeding. Trinexapac-ethyl will allow the use of less severe base preparation practices. Check the label for the type of turf and setting (greens, tees, electron transport chain.) Use upper- end label rates when there is strong bermudagrass competition. Use normal seeding rates and maintain fertility.
mefluidide (Embark 2S)	0.125	½ pts/15-150 gal water	Root 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 (Cutless 50W)	¾ to 1½ lb	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.
paclobutrazol (TGR Turf Enhancer 50 WP)	¼ lb	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.
Trimmit 2SC	0.1 to 0.5 lbs	6.4 to 32 oz	Root absorbed. Repeat applications may be made 4 to 6 weeks apart. Do not apply less than 2 weeks before and 6 weeks after overseeding. Read label for all directions. Do not apply to actively growing bermudagrass greens.

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 Florida Cooperative Extension Service, IFAS, and the University of Florida do 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.

ACTIVATED CHARCOAL FOR PESTICIDE DEACTIVATION

J. Bryan Unruh and Barry J. Brecke
Extension Turfgrass Specialist and Research Weed Scientist

Introduction

Occasionally an accidental spill will occur that must be cleaned up to continue growing grass. Or in a combination weed control and grass seeding program, it is necessary to stop the activity of an applied herbicide to successfully seed a grass. Charcoal is a very porous, soft, black substance made by heating, in a restricted amount of air, substances containing carbon. This is most often derived from hardwood trees and coconut shells. Charcoal adsorbs 100 to 200 times its own weight. The adsorption capacity is developed by activating the charcoal by heating. Its ultra fine-grained and irregular shape give charcoal an enormous surface areas.

Activated charcoal comes in handy for binding, thus, deactivating some herbicides. Activated charcoal will reduce the available level of most organic pesticides in the soil; however, it 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, aminotriazole, MSMA, and DSMA. In order to have effective application of activated charcoal, it is important to have the spraying equipment clean and in good operating condition. It is a good idea to keep a bag or two of activated charcoal in stock at all times when managing fine turf so it can be applied almost immediately instead of having to wait several days for delivery after an accidental spill or application.

General Mixing Instructions:

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.

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.

Application	Recommendation	Comments
Spills	For reducing the effects from spills of organic pesticides, some petroleum products, and hydraulic fluids.	Use 100 lbs of activated charcoal to every pound of active material spilled but no less than two pounds per 150 sq.ft. (600 lbs/acre) of contaminated area. 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 six inches. With severe spills, some of the contaminated soils may need removed prior to 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 the effect of a preemergence crabgrass herbicide, apply charcoal slurry at a rate of one lb per gallon of water for each 150 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.

Powdered activated charcoal is available as:

'DARCO Gro-Safe'
Norit Americas., Inc.
3200 University Avenue
Marshall, TX 57670
1-800-641-9245
www.norit-americas.com

'Clean Carbon'
Aquatrols
1273 Imperial Way
Paulsboro, NJ 08066
1-800-257-7797
www.aquatrols.com

'52 Pickup'
Parkway Research Corp.
13802 Chrisman Road
Houston, TX 77039
1-800-442-9821
www.parkwayresearch.com

WEED CONTROL IN IRRIGATION WATER SUPPLIES

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

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

Grass carp can be very effective for controlling most aquatic weeds. The major advantage is that there is no concern over damage to plants irrigated with herbicide treated water. Grass carp are usually used to control all vegetation in a pond, rather than selectively controlling certain vegetation. The most effective way to use grass carp is to initially control plants with a herbicide and then use grass carp to prevent regrowth of weeds. Replacement stocking of grass carp is necessary when fish are lost. A permit from the Florida Game and Freshwater Fish Commission is required to stock grass carp, and only triploid fish can be legally used.

Diquat, 2,4-D, endothall, glyphosate, fluridone, copper compounds, and triclopyr can be used safely in ponds used as irrigation sources if the manufacturer's label directions are followed. Certain waiting periods may be required before using water for irrigation after the herbicide is applied, while in some cases waiting periods are not required. Refer to the current herbicide label for this information.

For more complete information on aquatic weed control, see IFAS Circular SP334, "Weed Control in Ponds", IFAS Bulletin 867; "Grass Carp, A Fish For Biological Management of Hydrilla and Other Aquatic Weeds in Florida; IFAS publication SM-3, 'Aquatic Pest Control Applicator Training Manual'; and IFAS Circular 912, 'Aquascaping: Planting and Maintenance'.

Amount of Formulation for Application

Herbicide	Rate
Aquathol	0.3 to 2.6 gal/acre foot or 13 to 108 lb of 10G/acre foot.
Hydrothol	0.3 to 3.4 gal/acre foot or 11 to 136 lb of 11G/acre foot.
Diquat	1 to 2 gal/surface acre. <i>(24C for FL necessary for use rates above and up to 6 gal/surface acre - based on water depth.)</i>
2,4-D	1 to 2 gal/surface acre or 150 to 200 lb of 20G/surface acre.
Copper Compounds	0.1 to 3 ppm elemental copper.
Fluridone	0.375 to 0.5 gal/surface acre of 4AS or 30 to 50 lb of 5P/surface acre.
Glyphosate	4.5 to 7.5 pt/surface acre
Triclopyr	0.25 to 2.0 gal/surface acre for floating and emerged weeds. 0.75 to 2.5 ppm for submersed weeds.

Acre feet = average depth x surface acreage.

Effectiveness of Herbicides for Aquatic Weed Control								
	Endothall		Diquat	2, 4-D	Copper Compounds	Fluridone	Glyphosate	Triclopyr
	Aquathol	Hydrothol						
FLOATING PLANTS								
Duckweed (<i>Lemna</i> spp.)	*	*	G	*	*	E	*	*
Watermeal (<i>Wolffia</i> spp.)	*	*	*	*	*	G	*	*
Alligatorweed (<i>Alternanthera philoxeroides</i>)	*	*	*	F	*	F	G	G
SUBMERSED PLANTS								
Bladderwort (<i>Utricularia</i> spp.)	F	F	G	F	*	G	*	*
Brazilian elodea (<i>Egeria densa</i>)	*	*	E	*	F	G	*	*
Coontail (<i>Ceratophyllum</i> spp.)	E	E	E	F	*	E	*	F
Hydrilla (<i>Hydrilla verticillata</i>)	E	E	E	*	F	E	*	*
Parrotsfeather (<i>Myriophyllum aquaticum</i>)	F	F	F	F	*	F	*	F
Pondweed (<i>Potamogeton</i> spp.)	E	E	G	*	*	F	*	*
Slender naiad (<i>Najas minor</i>)	E	E	E	*	*	E	*	*
Souther naiad (<i>Najas quadalupensis</i>)	G	G	E	*	*	G	*	*
Spikerush (<i>Eleocharis baldwinii</i>)	*	*	*	*	*	G	*	*
Variable leaf milfoil (<i>Myriophyllum heterophyllum</i>)	G	G	G	E	*	G	*	G
EMERSED PLANTS								
American lotus (<i>Nelumbo lutea</i>)	*	*	*	G	*	G	G	G
Cattail (<i>Typha</i> spp.)	*	*	F	F	*	F	E	*
Fragrant waterlily (<i>Nymphaea odorata</i>)	*	*	*	G	*	G	E	G
Rush (<i>Juncus</i> spp.)	*	*	*	F	*	*	G	*
Spadderdock (<i>Nuphar</i> spp.)	*	*	*	F	*	G	E	E
Waterpennywort (<i>Hydrocotyle</i> spp.)	*	*	F	G	*	*	E	G
FILLAMENTOUS ALGAE	*	G	G	*	G	*	*	0

* = not recommended; G = Good; F = Fair; E = Excellent

Waiting Period (Days) Before Using Water After Application of Herbicides for Aquatic Weed Control**					
Common Herbicide Name	Trade Name	Irrigation	Fish Consumption	Watering Livestock	Swimming
Copper	Crystalline copper sulfate and various liquid organic copper complexes	NR*	NR	NR	NR
2,4-D	Various formulations and manufacturers	Water use restrictions vary by formulation and manufacturer. In general, if water is used for irrigating sensitive crops, 2,4-D should not be used. Turfgrasses are generally tolerant to low concentration of 2,4-D.			
Diquat	Reward Landscape & Aquatic Herbicide Diquat	1-5 days (Irrigation restriction based on rate used and whether target is food or non-crop)	NR	1 day	NR
Endothall	Aquathol K Aquathol granular Hydrothol 191 Hydrothol granular	7-25**	3 3 3 3	14 14 14 14	NR
Fluridone**	Avast Avast SRP Sonar 4AS Sonar 5P Sonar SRP	7-30** 7-30 7-30 7-30 7-30	NR NR NR NR NR	NR NR NR NR NR	NR NR NR NR NR
Glyphosate	Aquamaster Aquaneat Aquapro Eagre Glypro Rodeo	NR NR NR NR NR NR	NR NR NR NR NR NR	NR NR NR NR NR NR	NR NR NR NR NR NR
Triclopyr	Renovate	NR for established grasses. All other 120 days	NR	NR	NR

*NR = No restrictions;

**See label for specific information.

Pesticide Calibration Formulas and Information
 J. Bryan Unruh
 Extension Turfgrass Specialist

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

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 $\frac{\text{wt. of material to be used (lbs)} \times 1,000,000}{\text{wt. of tank mixture (lbs)}}$
	= $\frac{1,000,000 \times \text{oz commercial material used} \times \% \text{ ai (decimal)}}{\text{gal/tank} \times 8.34 \times 16}$
	= $\frac{1,000,000 \times \text{fl.oz. used} \times \text{lb ai/gal}}{\text{gal/tank} \times 8.34 \times 128}$
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	= $\frac{\text{ai (decimal)} \times 8.34 \text{ gal/tank}}{\text{ai per gal} \times 100}$
% 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/acre	= $\frac{\text{lbs ai to be applied per acre}}{\text{lbs ai per gallon}}$
gal commercial material/tank	= $\frac{\text{gallons/tank} \times \text{lb ai to be applied per acre}}{\text{gallons/acre} \times \text{lbs ai per gallon}}$

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

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
basic metric unit = 1					

Approximate Rates of Application Equivalents

	<u>weights</u>	
1 oz/ft ²	= 2722.5 lbs/A	
1 oz/yd ²	= 302.5 lbs/A	
1 oz/100 ft ²	= 27.2 lbs/A	
1 oz/1000 ft ²	= 43.46 oz/A	= 2.72 lbs/A
1 lb/A	= 1 oz/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	

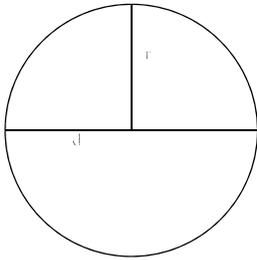
	<u>Liquid</u>
1 oz/1000 ft ²	= 43.56 oz/A = 1.4 qt/A
1 pt/1000 ft ²	= 5.4 gal/A
100 gal/A	= 2.3 gal/1000 ft ² = 1 qt/100 ft ²

Approximate Weight of Dry Soil

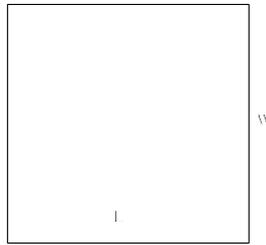
Type	lbs/ft ³	lbs/acre (6 inches deep)
sand	100	2,143,000
loam	80-95	1,714,000
clay or silt	65-80	1,286,000
muck	40	860,000
peat	20	430,000

Helpful Calculations and Formulas:

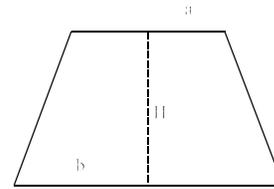
Rectangle, square or parallelogram:	area	=	length (L) x width (W)	
Trapezoid:	area	=	[a + (b x h)] ÷ 2	
Circle:	area	=	radius (r)² x 3.1416 (π)	= diameter (d)² x 0.7854
	radius	=	d ÷ 2	
	diameter = circumference	=	r x 2 π x d	
Sphere:	volume	=	r³ x 4.1888	= d³ x 0.5236
Triangle:	area	=	(W x H) ÷ 2	
Cylinder:	volume	=	r² x 3.1416 x L	
Finding Tank Capacity (gallons):				
Cylindrical tanks:	(inches)	=	L x d² x 0.0034	
	(feet)	=	L x d² 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	



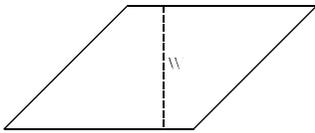
Circle



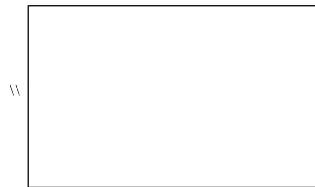
Square



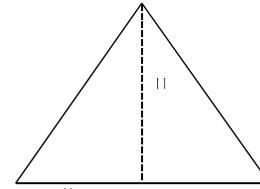
Trapezoid



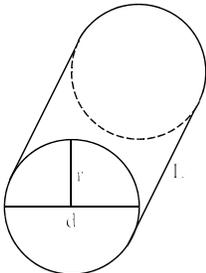
Parallelogram



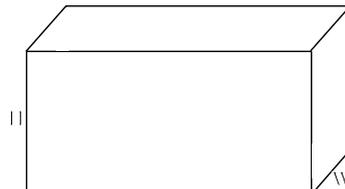
Rectangle



Triangle



Cylindrical Tank



Rectangular Tank

Metric System Conversion Factors

J. Bryan Unruh

Extension Turfgrass Specialist

Area Equivalents

1 acre = 43,560 ft² = 4840 yd² = 0.4047 hectares = 160 rods² = 4047 m² = 0.0016 sq. mile
 1 acre-inch = 102.8 m³ = 27,154 gal = 3630 ft³
 1 hectare (ha) = 10,000 m² = 100 are = 2.471 acres = 107,639 ft²
 1 cubic foot (ft³) = 1728 in³ = 0.037 yd³ = 0.02832 m³ = 28,320 cm³
 1 cubic yard (yd³) = 27 ft³ = 0.765 m³
 1 square foot (ft²) = 144 in² = 929.03 cm² = 0.09290 m²
 1 square yard (yd²) = 9 ft² = 0.836 m²

Liquid Equivalents

1 ft³ of water = 7.5 gal = 62.4 lbs. = 28.3 liters
 1 acre-inch of water = 27,154 gal = 3630 ft³
 1 liter (l) = 2.113 pts. = 1000 ml = 1.057 qts. = 33.8 fl.oz. = 0.26 gal
 1 US gallon = 4 qt. = 8 pt. = 16 cups = 128 fl.oz. = 8.337 lbs of water = 3.785 L = 3785 ml = 231 in³ = 256 tbsp. = 0.1337 ft³
 1 quart = 0.9463 liters = 2 pt. = 32 fl. oz. = 4 cups = 64 tablespoons (tbsp.) = 57.75 in³ = 0.25 gal = 946.4 ml
 1 pint = 16 fl. oz. = 2 cups = 473.2 ml = 32 level tablespoons = 0.125 gal = 0.5 qt
 1 cup = 8 fl. oz. = ½ pt. = 16 tablespoons = 236.6 ml
 1 tablespoon = 14.8 ml = 3 teaspoons (tsp.) = 0.5 fl.oz.
 1 teaspoon = 4.93 ml = 0.1667 fl. oz. = 80 drops
 1 US fluid ounce = 29.57 ml = 2 tablespoons = 6 tsp. = 0.03125 qt
 1 milliliter (ml) = 1 cm³ = 0.34 fl.oz. = 0.002 pts

Temperature Equivalents

degrees Centigrade = (°F-32)x5/9
 degrees Fahrenheit = (°Cx9/5)+32

Pressure Equivalents

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

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 pt/100 gal = 1 teaspoons/1 gal
 1 qt/100 gal = 2 tablespoons/1 gal

Flow

1 gpm = 0.134 ft³/minute
 1 ft³/min. (cfm) = 449 gal/hr. (gph) = 7.481 gal/min.

Weight Equivalents

1 ton (US) = 2000 lb = 0.907 metric tons = 907.2 kg
 1 metric ton = 10⁶ g = 1000 kg = 2205 lb
 1 lb = 16 oz = 453.6 grams (g) = 0.4536 kg
 1 oz (weight) = 28.35 g = 0.0625 lb
 1 gram = 1000 mg = 0.0353 oz = 0.001 kg = 0.002205 lb
 milligrams (mg) = 0.001 grams
 1 kilogram (kg) = 1000 grams = 35.3 oz = 2.205 lbs
 microgram (µg) = 10⁻⁶ grams = 0.001 mg
 nanogram (ng) = 10⁻⁹ grams = 0.001 micrograms (µg)
 picogram = 10⁻¹² grams
 1 ppm = 0.0001% = 0.013 fl oz in 100 gal = 1 mg/kg = 1 mg/L = 1 µg/g = 0.379 g in 100 gal water = 8.34 x 10⁻⁶ lb/gal = 1 µl/l
 10 ppm = 0.001% = 10 mg/L 100 ppm = 0.01% = 100 mg/L 1000 ppm = 1mg/g = 0.1% = 1000 mg/L
 1 ppb = 1 µg/kg or 1 µg/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

Conversion Factors

To Convert	Multiply by	To Obtain
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
Bar	14.5	Lb/sq.in.
Bar	1019.7	g/cm ³
Bar	29.53	inches Hg @ 0°C
Bushels (dry)	0.03524	m ²
Centimeters (cm)	0.03281	Feet
Centimeters	0.3937	Inches
Centimeters	0.1094	Yards
Centimeters	0.01	Meters
Centimeters	10	Millimeters (ml)
cm/sec	1.9685	ft/min
cm/sec	0.0223694	MPH
cm ³	0.0610237	inch ³
Cubic feet (ft ³)	0.0283	Cu. meter
Cubic feet	7.4805	Gallons
Cubic feet	1728	Cubic inches
Cubic feet	0.037	Cubic yards
Cup	8	fl oz
Feet (ft)	30.48	Centimeters
Feet	0.3048	Meters
Feet per minute	0.01136	MPH
Foot candle	10.764	Lux
Gallons (gal)	3.785	Liters
Gal	3785	Millimeters
Gal	128	Ounces (liquid)
Gal/acre	9.354	Liters/hectare
Gal/1000 ft ²	4.0746	L/100 m ²
Gal/minute	2.228 x 10 ⁻³	Cubic feet/second
Grams (g)	0.002205	Pounds
Gram	0.035274	oz
Grams per liter	1000	PPM
Grams per liter	10	Percent
Grams/sq.meter	0.00020481	lb/sq.foot
G/cm ³	0.036127	lb/in ³
G/cm ³	62.428	lb/ft ³
Hectares (ha)	2.471	Acres
Inches	2.540	Centimeters
Inches	0.0254	Meters
Inches	25.40	Millimeters
In ²	6.4516	cm ²
In ³	16.3871	cm ³

To Convert	Multiply by	To Obtain
Kilograms (kg)	2.2046	Pounds
Kg/hectare	0.892	Pounds/acre
Kg/ha	0.02048	lb/1000 ft ²
Kg/L	8.3454	lb/gal
Kilometers (Km)	100,000	Centimeters
Kilometers	3281	Feet
Kilometers	1000	Meters
Kilometers	0.6214	Miles
Kilometers	1094	Yards
Km/h	0.62137	MPH
Km/h	54.6807	ft/min
Kilopascals (kPa)	0.145	Pounds/sq.in. (psi)
Liters (l)	0.2642	Gallons
Liters	33.814	Ounces
Liters	2.113	Pints
Liters	1.057	Quarts
L/100 m ²	0.2454	gal/1000 ft ²
Liters/hectare	0.107	Gallons/acre
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 ³	35.3147	ft ³
M ³	1.30795	yd ³
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
Millimeters (mm)	0.03937	Inches
Ounces (fluid)	0.02957	Liters
Ounces (fluid)	29.573	Milliliters
Ounces (weight)	28.35	Grams
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	8.345	lbs/million gal of water
Percent (%)	10	g/kg
Pint	0.473	liter
pt/A	1.1692	L/ha

To Convert	Multiply by	To Obtain
Pounds	0.4536	Kilograms
Pounds	453.6	Grams
Pounds/acre	1.12	Kg/hectare
Pounds/A	0.02296	lb/1000 ft ²
Pounds/sq.ft.	4883	Grams/sq.meter
Pounds/1000 ft ²	43.5597	lb/A
Pounds/yd ³	0.0005937	G/cm ³
Pounds/gallon	0.12	Kg/liter
PSI (lbs/sq.in.)	6.9	Kilopascals
PSI	0.06895	Bar
PSI	0.068046	atm
Quarts	0.9463	Liters
Qt/A	2.3385	L/ha
Sq. centimeters	0.001076	Sq. feet
Sq. centimeters	0.1550	Sq. inches
Sq. feet	929	Sq. centimeters
Sq. feet	0.0929	Sq. meters
Sq. feet	9.294 x 10 ⁻⁶	Hectares
Sq. inch	6.452	Sq. centimeters
Ton (2000 lbs)	907	kg
Yards	91.44	Centimeters
Yards	0.9144	Meters
Yards	914.4	Millimeters
yd ³	27	ft ³
yd ³	0.7645	m ³
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
3/16	0.1875	4.762
11/64	0.171875	4.366
5/32	0.15625	3.969
9/64	0.140625	3.572
⅛	0.1250	3.175
7/64	0.109375	2.778
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

PESTICIDE APPLICATION RECORD

Company Name Commercial Applicator
 Application Date & Time Site Location
 Pesticide License Category Number
 Pesticide Name(s) Manufacturer
 EPA Registration No. Restricted-entry Interval (REI)
 Active Material & Formulation
 Lot No. % Concentration
 Safety Equipment Needed

APPLICATION INFORMATION

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

WEATHER CONDITIONS

Air Temperature (°F) % Relative Humidity Dew Presence (Y/N)
 Initial Wind Velocity (MPH) Wind Direction
 First Hour Second Hour Third Hour
 Soil Temperature at 4 inches (F) Soil Moisture % Cloud Cover

APPLICATION EQUIPMENT

Method of Application Speed (mph) Motor Speed (RPM) Nozzle Type Number
 Nozzle Height Spacing Boom Width Gallon Per Acre (GPA) Spray Pressure (PSI)
 Nontarget Plant, Animal, or Human Exposure: Yes _ _ No_ _ (If yes, list corrective or emergency action taken)

Other Comments:

Signature

_ Date

Emergency Pesticide Information

Fred Fishel, Ph.D.
UF/IFAS Pesticide Information Coordinator

Poison Information Center: 1-800-222-1222

The Poison Information Center toll free hotline automatically links a caller in Florida to emergency services on poison prevention and management provided by one of three centers located in Jacksonville, Miami, and Tampa. Each center in the Florida Poison Information Center Network is certified by the American Association of Poison Control Centers as a Regional Poison Control Center and is located on the campus of a major teaching hospital. Emergency and information calls placed to the Network are assessed, triaged, managed and followed by specially trained nurses, pharmacists, physician assistants, physicians and on-call board certified toxicologists.

Web address: <http://www.aapcc.org/states/fl.htm>

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

The National Pesticide Information Center (NPIC) is a cooperative effort of Oregon State University and the U.S. Environmental Protection Agency. NPIC is a toll-free telephone service that provides pesticide information to any caller in the United States, Puerto Rico, or the Virgin Islands. NPIC provides objective, science-based information about a wide variety of pesticide-related subjects, including:

- pesticide products
- recognition and management of pesticide poisoning
- toxicology
- environmental chemistry

NPIC staff have toxicology and environmental chemistry education and training to provide knowledgeable answers to pesticide questions. NPIC's toll free call center is staffed 9:30 am to 7:30 pm Eastern time, 7 days a week excluding holidays.

Web address: <http://npic.orst.edu>

CHEMTREC® (Chemical Transportation Emergency Center) 1-800-424-9300

The Chemical Transportation Emergency Center (CHEMTREC®), located in the Washington, DC area, is maintained by the American Chemistry Council. Its purpose is to be a public service hotline for fire fighters, law enforcement, and other emergency responders to obtain information and assistance for emergency incidents involving chemicals and hazardous materials. In addition CHEMTREC helps shippers of hazardous materials comply with the US Department of Transportation Hazardous Materials regulations. Because many companies use CHEMTREC, the emergency number appears frequently on shipping documents, material safety data sheets, rail cars, trucks, and other containers. Companies that list CHEMTREC's emergency number must be registered with CHEMTREC, which includes payment of an annual fee. Thousands of manufacturers and shippers worldwide rely on the CHEMTREC Emergency Call Center to provide information and technical assistance for emergencies involving their products. CHEMTREC maintains a state-of-the-art communications center and a high-end MSDS document storage and retrieval system, containing nearly 2.8 million MSDSs. These sheets are updated and maintained in cooperation with the registrants and are indexed for rapid retrieval.

Web address: <http://www.chemtrec.org/>

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