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PEST MANAGEMENT GUIDELINES FOR AGRICULTURE

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UC PEER REVIEWED

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The UC IPM Pest Management Guidelines are available from:

- Online: http://ipm.ucanr.edu
- UC Cooperative Extension County Offices
- University of California
  ANR Communication Services
  Richmond, CA 94804
  510-665-2195; 800-994-8849

Updates: These guidelines are updated regularly. Check with your University of California Cooperative Extension Office or the UC IPM website for information on updates.

Note to readers: These guidelines represent the best information currently available to the authors and are intended to help you in making the best choices for an IPM program. Not all formulations or registered materials are mentioned. Always read the label and check with local authorities for the most up-to-date information regarding registration and restrictions on pesticide use. Check with your agricultural commissioner for latest restricted entry intervals.

General Information

(Section reviewed 7/09)

TURFGRASS SPECIES (9/09)

Proper selection of a turf species is an important component of an integrated pest management program. When turf species are planted in areas where they are not well adapted, they require greater care to grow and maintain and are more susceptible to invasion by pests. The major species used for turfgrass in California are outlined below. Cultivars are continually being developed or improved. For the latest information, consult your farm advisor or local nursery. See the UC Guide to Healthy Lawns (http://ipm.ucdavis.edu) for help identifying turfgrass species as well as information on establishing and maintaining a healthy stand of turfgrass in INTEGRATED WEED MANAGEMENT.

BENTGRASS (*Agrostis* spp.)

Two species of bentgrass commonly used for turf are colonial and creeping bentgrasses. Colonial bentgrass is best adapted to the coastal region in far northern California where it is used for general lawn areas. It is a fine-textured grass with upright leaves and dense growth. Colonial bentgrass grows best in cool, humid weather, and can tolerate some shade; it has low tolerance to heat, salinity, water stress, and traffic. Colonial bentgrass requires frequent irrigation because it has a shallow root system. It tends to be susceptible to a wide range of diseases.

Creeping bentgrass is a specialty grass used for golf course putting greens, lawn bowling greens, and lawn tennis facilities. It is capable of withstanding very low cutting heights. Creeping bentgrass is a very fine-textured grass with flat, narrow leaves, a bright green color, and a shallow root system. It requires a high level of nitrogen fertilization and needs to be irrigated fairly frequently because of its shallow roots. It is not suitable for home lawns or other general-purpose turf.

KENTUCKY BLUEGRASS (*Poa pratensis*)

Kentucky bluegrass (produces a dense turf with dark green, medium-textured leaves; it spreads by rhizomes. Kentucky bluegrass grows best in fall, winter, and spring when temperatures are cool; during summer its growth slows. Kentucky bluegrass requires frequent irrigation during the summer months because of its shallow root system. It is susceptible to heat stress and disease infestation.

RYEGRASS (*Lolium* spp.)

The species of ryegrass used for turfgrass are annual and perennial ryegrass. Annual ryegrass is used principally for overseeding bermudagrass in winter: it is well adapted to sunny conditions and survives well during the cooler months. Annual ryegrass has low heat tolerance, is coarse textured, and shiny light green. It dies in late spring to early summer.

Perennial ryegrass is well adapted to sunny or partially shady conditions. It grows best during periods of cool temperatures and is very competitive, rapidly establishing a uniform green cover. Fall seeding is preferred. Perennial ryegrass has a bunchgrass-type growth habit, thus open areas should be reseeded. It is extremely vigorous in its growth, particularly in the seedling stage, thus minimizing weed invasion.

KENTUCKY BLUEGRASS AND PERENNIAL RYEGRASS MIX

For general lawns, mixing Kentucky bluegrass and perennial ryegrass is preferred over planting either species singly. The mixture results in a more disease-resistant turfgrass stand offering good color and year round growth. By weight, at least 15 percent perennial ryegrass seed is recommended in the mixture.

TALL FESCUE (*Festuca arundinacea*)

Tall fescue is well adapted to sunny or partially shady conditions. It is coarse-textured, although newer cultivars are finer textured, but not as fine as Kentucky bluegrass or perennial ryegrass. Tall fescue has good disease resistance and excellent tolerance to heat stress. Unlike bermudagrass or Kentucky bluegrass, tall fescue is a bunch-type grass, thus open areas need to be reseeded. The vigorous growth of improved turf-type tall fescue cultivars is a deterrent to weed invasion, although the very "dwarf" (slow-growing) varieties may be less competitive.

FINE FESCUES (*Festuca* spp.)

Fine fescues are cool-season turfgrasses that can have either a clumped or creeping type of growth. These grasses have a very fine texture because their leaf blades are very narrow. Several species of fine fescues are used as turfgrasses in California: creeping red fescue (*Festuca rubra*), Chewings fescue (*F. rubra commutata*), and hard fescue (*Festuca longifolia*). Fine fescues make a dense, wear-resistant turf when well established. They are usually mixed with other turf species because they tolerate shade well and fill in shady areas. Fine fescues do not like excessive nitrogen and are often mowed at 1.5 to 2.5 inches to tolerate heat in California. However, hard fescue, as well as red fescue, can be left unmowed as ornamental ground covers or on slopes and other hard-to-mow areas.

COMMON BERMUDAGRASS (*Cynodon dactylon*)

Common bermudagrass is drought tolerant and well adapted to sunny conditions. It is a medium, coarse-textured grass with a gray green color, but it becomes dormant and loses its color in cold weather. Common bermudagrass establishes a deep root system and produces long rhizomes and stolons. Plant common bermudagrass in spring or summer at a rate of 1 lb seed/1000 sq. ft. Common bermudagrass requires frequent mowing to maintain an attractive quality. It has good wear quality when it is growing, but produces heavy thatch and can produce thatch in light traffic areas. There are new seeded cultivars of common bermudagrass that have improved turfgrass quality characteristics.

HYBRID BERMUDAGRASS (*Cynodon* spp.)

Cultivars of hybrid bermudagrass include Tifgreen, Tifway II, and Santa Ana. All hybrid bermudagrass cultivars form thatch that must be removed periodically by verticutting. Hybrid bermudagrasses are drought tolerant, but good irrigation practices will enhance their competitiveness.

Tifgreen is well adapted to sunny conditions. It becomes dormant and loses color during periods of cold temperatures, but less than common bermudagrass. This cultivar is fine textured with dense, prostrate growth. It produces few seed heads and has a deep blue green color.

Tifway II is also well adapted to sunny conditions. It retains its color in winter better than any of the other bermudagrasses. This cultivar has a medium fine texture, a dark green color, and dense growth; it can withstand traffic better than Tifgreen.

Santa Ana has excellent wear characteristics and a dark color. Its requirements are similar to those of the other hybrids, but Santa Ana is more tolerant of smoggy conditions.

KIKUYUGRASS (*Pennisetum clandestinum*)

Kikuyugrass is well adapted to coastal regions within fifty miles of the ocean in southern California and central California. It has spread to some of the inland valleys as well. Kikuyugrass is a coarse-textured, hairy, light green, perennial, warm-season grass that spreads aggressively by very thick rhizomes and stolons; its leaves are coarse textured and hairy. Kikuyugrass has good drought, heat, and wear tolerance, but it is difficult to mow and is prone to thatch heavily. Because of its aggressive growth it is a weed in some situations.

ST. AUGUSTINEGRASS (*Stenotaphrum secundatum*)

St. Augustinegrass is well adapted to areas with full sun or moderate shade; it is the most shade tolerant warm-season grass. It is a coarse-textured, creeping grass of medium green color. St. Augustinegrass is propagated by stolons and forms a dense, prostrate turf that is virtually weed free, but thatch is a severe problem. St. Augustinegrass frequently needs iron as a fertilizer supplement. It is relatively drought tolerant. It can withstand extremely saline conditions.

ZOYSIAGRASS (*Zoysia japonica*)

Zoysiagrass grows well in full sun, although it is tolerant of moderate shade. Zoysiagrass is medium textured, dark green in color, and is slow to establish from stolons or rhizomes. It turns brown when it is dormant in winter. Zoysiagrass is an attractive, uniform, dense, low-growing, good quality grass that requires less fertilization than bermudagrass. Zoysiagrass is moderately deep rooted and thus requires infrequent irrigation. Vertical mowing is needed periodically to reduce excessive thatch and scalping.

DICHONDRA (*Dichondra micrantha*)

Dichondra is not a turfgrass but a low-growing perennial. It will grow in partial shade, but it does best in full sun under cool coastal conditions. Mowing dichondra is a matter of personal preference; it may either remain unmowed or be mowed. Dichondra has a deep root system when properly irrigated. Frequent irrigation to maintain dichondra increases weed invasion; it is also very susceptible to flea beetles and nematode injury.

Insects and Mites

(Section reviewed 7/09)

MONITORING and TREATING INSECTS and MITES (9/09)

It is important to accurately identify insects found in turfgrass stands because many of them are not pests. In addition, the most effective treatment for one pest may not satisfactorily control another. Lawns tolerate moderate levels of most insect pests and insecticide treatments are infrequently needed in California. Be sure that insects are present at damaging levels before applying insecticides (see Table below).

To detect cutworms, sod webworms, southern chinch bugs, fiery skipper larvae, and billbug adults, use the drench test. To carry out this test, mix one to two fluid ounces of liquid dishwashing soap in 1 gallon of water. Apply the solution to 1 square yard of turf as evenly as possible using a sprinkling can. This will irritate the insects so that they move to the surface within 10 minutes. Use the descriptions in this guideline to accurately identify the insects. White grubs (larval stages of masked chafers, May beetles and June beetles), black turfgrass ataenius larvae, and billbug larvae will not respond to the drench test. To detect white grubs, dig or cut beneath thatch and examine the soil around roots and crowns (where roots and stems meet). Look for the white, legless larvae of billbugs (a weevil) or the C-shaped, six-legged larvae of scarab beetles such as black turfgrass ataenius and masked chafers. When these are numerous, roots are eaten away and turf often can be rolled back like a carpet.

In large lawn areas such as parks, golf courses, and cemeteries, monitor several locations to determine the extent of an infestation. Certain pests, such as white grubs, often repeatedly infest limited areas where adults prefer to lay their eggs. If problems are localized, spot treatments may be suitable. Don't treat for insect pests unless treatment thresholds are exceeded as indicated in the following table.

Lawn Insect Detection Methods, Treatment Targets, and Thresholds for Common Lawn Insects In California

Insect	Detection method	Treatment target	Suggested treatment threshold
Armyworms, cutworms	Use a drench test to look for fat, dull gray, green, or brownish larvae up to 2 inches long; inspect outdoor lights around dawn for 1-1/4-inch brownish to gray moths	crowns, leaves, thatch	5/yd^2
Billbugs	Dig around roots for whitish, c-shaped, legless grubs up to 3/8 inch long with reddish heads; inspect outdoor lights around dawn for 1/3 inch brownish to gray snout beetles	crown, roots	1 to 10/ft^2 varies with turf species and climate*
Black turfgrass ataenius (see also white grubs)	Dig around roots for whitish, c-shaped grubs up to 1/3 inch long with 6 legs and reddish heads; inspect outdoor lights around dawn for shiny black adults 1/5 inch long	roots, thatch soil interface	40/ft^2
Chinch bug, southern	Drench test or inspect around grass bases for reddish, purple, black, or gray bugs up to 1/2 inch long	crowns, stems	135/yd^2 or 15 nymphs & adults/ft^2
Lawn moths (sod webworms)	Drench test for slender, grayish larvae up to 3/4 inch long; whitish or brownish moths up to 3/4 inch long fly when grass is disturbed	crowns, leaves, thatch	15/yd^2
Skipper, fiery	Drench test for larvae up to 1 inch long with pink-green body and red and black head; orangish butterflies 1 inch wide with knobbed antennae feed at flowers; mere presence of this insect does not warrant control	leaves, stems	15/yd^2
White grubs (the immatures of masked chafers, may and june beetles; see also black turfgrass ataenius)	Dig around roots in late winter or summer for whitish to yellow, wrinkled, c-shaped grub up to 1-1/2 inches long with 6 legs and a reddish head; look for yellowish brown adults 1/2 inch long	roots	6/ft^2

*Threshold for application of curative insecticides. Preventive treatments (e.g., imidacloprid and other neonicotinoids) applied early season when adults are laying eggs are often most effective where grubs are a regular problem in high value turf.

TREATMENTS

Vigorous turfgrass on most California lawns, school playing fields, and parks has few insect problems, and insecticide treatments are infrequently needed and only when monitoring indicates that damage thresholds have been exceeded. More intensively managed turfgrass such as golf courses, putting greens, and professional sports fields tend to have more insect problems and are treated more often.

Before applying a treatment for foliar or thatch-dwelling pests, irrigate the turf well and then treat as soon as the plants dry. Apply the required amount of insecticide in enough water to thoroughly wet the grass down to the ground; for foliage feeders such as the fiery skipper, sod webworm, armyworms, and cutworms, 2 to 5 gallons of water per 1,000 square feet of turf works well. The bermudagrass mite as well as the root-feeding pests (billbugs, black turfgrass ataenius) require a greater volume of water (25 gallons per 1,000 square feet) to move the pesticide into the area where the pest is feeding. Insects that feed in the thatch layer (southern chinch bug) should have treatments applied in 10 to 25 gallons of water per 1,000 square feet of turf. Do not irrigate following a chemical application until necessary to prevent wilting; this will allow the insecticide to remain on the plants for the longest possible period. Do not apply insecticides when temperatures exceed 90° F or to water-stressed dichondra.

When applying parasitic nematodes, irrigate before and after the application. In addition, soil temperatures must also be above 60° F when applying nematodes. During hot weather, apply nematodes in the morning or late evening and irrigate every few days for 2 weeks after the application to keep the soil moist, but not soggy. When treating for pests that feed below ground on grass roots, irrigate following application.

In general, sprays work best when treating foliar turfgrass pests, but granular formulations are acceptable for controlling white grubs, billbugs, chinch bugs, cutworms, skipper larvae, and sod webworms. Granules are advantageous when attempting to control pests residing in or below the thatch layer because they move past leaf blades and partially penetrate the thatch layer. However, granular insecticides are often a second choice relative to wettable powders or emulsifiable concentrate formulations because they do not work as fast and because of accidental ingestion by birds. Special care must also be taken to assure granules do not remain on hard surfaces and get washed into storm drains.

To help prevent the development of resistance to a pesticide, rotate pesticides with different mode-of-action group numbers. These numbers are listed with each pesticide in the treatment tables throughout this guideline.

Predators and parasites of turfgrass pests are disrupted by broad-spectrum insecticides such as pyrethroids (e.g., cyfluthrin), carbamates (carbaryl), and to a lesser extent, organophosphates (e.g., acephate) and imidacloprid. Alternatives such as spinosad, insect pathogenic nematodes, and *Bacillus thuringiensis* (Bt) control a narrower range of organisms, thus preserving naturally occurring beneficial insects. The pathogenic nematode, *Steinernema carpocapsae,* applied to control cutworms and black turfgrass ataenius may be as effective as some conventional insecticides, but timing the applications correctly is critical to their effectiveness. Because nematodes are killed by light and heat, make applications in the evening, especially in hot areas and sunny locations. Bt products are typically inexpensive, but timing is also very critical for achieving control; use of this material requires additional scouting. The additional material expense of nematodes or effort involved in scouting when using Bt has the ultimate payoff in allowing natural enemies, such as scoliids and tiphiids (white grub parasites) and adults and nymphs of bigeyed bugs (Geocoris), to remain part of the turf system. (Nematodes must usually be mail ordered. They are perishable, so store them as directed by the label. For a list of reputable sources, consult *http://www2.oardc.ohio-state.edu/nematodes.*

AUSTRALIAN SOD FLY (9/09)

Scientific name: *Inopus rubriceps*

DESCRIPTION OF THE PEST

In California, the Australian sod fly is occasionally found only in the San Francisco Bay Area. Adult male flies are 0.25 inch (6 mm) long and black with yellowish legs. Females are 0.4 inch (9.5 mm) long, black, with reddish legs and a red head. Adults may be active in May, but their major period of activity is from September through November. Eggs are laid in the soil. After hatching, larvae may take 2 years to complete development. Fully grown larvae are 0.5 inch (1.3 cm) long maggots with flattened, distinctly segmented bodies that are light tan with a coarsely granular surface. There are six long, stiff bristles per segment, no legs, and a distinct, conical black head capsule. The flattened and distinctly segmented body of the sod fly larvae easily distinguishes this species from other maggots, such as the march fly, that occur in turf but mostly feed on decaying organic matter.

SUSCEPTIBLE SPECIES

All turf species.

DAMAGE

Australian sod fly larvae feed on sap from the roots of grasses. As a result of their feeding, grass declines and is replaced over time with broadleaf weeds.

MANAGEMENT

There are no known biological or cultural controls and no registered chemical controls. A well maintained, adequately irrigated, vigorously growing turf stand can normally withstand a moderate sod fly infestation.

BERMUDAGRASS MITE (12/16)

Scientific name: *Eriophyes cynodoniensis*

DESCRIPTION OF THE PEST

The bermudagrass mite is an eriophyid mite that is so small it can barely be seen even with a 10X hand lens. It has a wormlike shape with all four legs and mouthparts at the anterior end. Eggs are spherical, transparent, and about one-third the length of the adult mite. They are laid under leaf sheaths. One generation (from egg through two nymphal stages and reaching the egg-laying adult stage again) takes 7 to 10 days in summer when temperatures are in the 80° to 110° F range.

SUSCEPTIBLE SPECIES

Common bermudagrass. Hybrid bermudagrass is resistant.

DAMAGE

Adult and immature mites suck juices and inject toxic saliva that shortens internodes and swells leaf sheaths, forming a witches'-broom growth pattern. Damage first appears in spring and is followed by dieback and browning in summer.

MANAGEMENT

If bermudagrass mite is infesting turfgrass, reducing nitrogen fertilization and close mowing or scalping with removal of clippings can slow down reproduction of, or physically remove, bermudagrass mites. To confirm presence of this mite, examine leaf sheaths of stunted plants with a 10X or 30X hand lens for mites and their eggs. Damage thresholds have not been established for this pest, but if a treatment seems necessary, mow the turf closely and remove clippings first. In addition to physically removing most of the population, it may also displace remaining mites so that they are more readily contacted by the miticide. After mowing, irrigate the turf and spray while the grass is still wet. To increase the chance of getting the pesticide under the leaf sheath, add adequate spreader-sticker to the spray mixture. Do not water or cut the grass within 24 hours of chemical treatment. A second application 10 days after the first may be necessary to obtain satisfactory control.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. BIFENTHRIN (Talstar)	Label rates	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Not for use on sod farms or in commercial seed production. May cause water quality issues. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. DELTAMETHRIN (DeltaGard G)	2–3 lb	—	—
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: To control adults. Not for use on sod farms or in commercial seed production. For best results, irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and to dissolve the granules.			

** Apply sprays in 25 gal water/1000 sq ft.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

BERMUDAGRASS SCALE (9/09)

Scientific name: *Odonaspis ruthae*

DESCRIPTION OF THE PEST

Bermudagrass scales are 0.06 inch (1.6 mm) long, clam-shaped, and white armored. They are found on the crown, stolons, and under leaf sheaths of bermudagrass. High populations of bermudagrass scales create a whitish, moldy appearance on stems and crowns. Close examination of the grass with a hand lens will help to distinguish the clam-shaped shields.

The adult female produces eggs under her body covering. These hatch into crawlers that move to a new location, settle down, start to suck juices from the grass, and molt into the familiar sessile form. There are two or three generations a year.

SUSCEPTIBLE SPECIES

Hybrid and common bermudagrass.

DAMAGE

Bermudagrass scale occurs most frequently in shaded lawn areas and is favored by an overabundance of thatch. Feeding stunts the bermudagrass and results in a drought-stressed appearance. Bermudagrass suffering from other stresses, such as shade or drought, is especially susceptible and infestation can result in death.

MANAGEMENT

To manage bermudagrass scale in turfgrass, reduce the amount of shade in the turf by removing excessive thatch, which increases light penetration. Some of the bermudagrass scale population will also be removed with the thatch. Do not plant bermudagrass in heavily shaded areas. There are no registered chemical control options.

BILLBUGS (12/16)

Scientific names
Phoenix billbug: *Sphenophorus phoeniciensis*
Hunting billbug: *Sphenophorus venatus vestitus*

DESCRIPTION OF THE PESTS

The Phoenix and hunting billbug adults are dark brown and light brown, respectively. Both are 0.33 inch long weevils (snout beetles) with a long, downward-pointing snout and elbowed, clubbed antennae. The Phoenix billbug is more common in California than the hunting billbug. The hunting billbug can be identified by a Y-shaped marking on the thorax with separate, inward-facing marks that resemble parentheses on either side of the Y. These two marks in the Phoenix billbug combine to form an M. Adults are often seen walking on paved areas, but are difficult to find on golf courses unless a drench test is used. Eggs are inserted into the turfgrass stems. They hatch about 6 to 8 weeks after adults first appear. Larvae are creamy white, legless, and somewhat hunch-backed C-shaped grubs with a brown head. The lack of legs distinguishes billbug grubs from white grubs. Adults may be found all year round.

SUSCEPTIBLE SPECIES

Although all species of turfgrass can be attacked, serious damage is seen primarily on bermudagrass and zoysiagrass. Zoysiagrass is preferred by hunting billbugs while phoenix billbugs prefer bermudagrass.

DAMAGE

Billbug larvae first feed on the inside of the turfgrass stem and crown, then move into the soil where they feed on roots. Fine, whitish, sawdustlike larval excrement (frass) can be observed on the soil surface. Billbug larvae feed higher up on the roots than white grubs, so billbug-damaged turf is easier to pull from the soil than that damaged by white grubs because it breaks at the crown. Billbugs may feed on roots to a depth of 3 inches; however, unlike turf damaged by white grubs damaged turf cannot be rolled back like a carpet and the soil does not feel spongy underfoot. Turfgrass planted on fumigated soil is especially susceptible to damage because of the loss of natural enemies. Drought-stressed turfgrass may be severely impacted.

MANAGEMENT

Where possible choose resistant varieties of bermudagrass and zoysiagrass or other less susceptible turf species. Perennial ryegrasses with endophyte fungal enhancement are resistant to billbug attack and can be used to overseed in fall. Good irrigation, fertilizing, and mowing practices may allow turf to tolerate low levels of billbugs.

If you suspect a billbug infestation, look for piles of fine frass at the base of turfgrass plants. In areas where frass or damage is evident, dig up the turfgrass to look for grubs. (For more information on monitoring, see MONITORING AND TREATING INSECTS AND MITES. Commercially available nematodes, *Steinernema carpocapsae* or *Heterorhabditis bacteriophora,* often control billbug larvae, especially in sod farms or other locations where the soil has been fumigated. Apply nematodes to moist turf and irrigate following application of either nematodes or chemical insecticides to move the material into the zone of larval feeding activity.

With overlapping generations and a long season in California, billbugs are difficult to control with insecticides. Preventive grub materials (imidacloprid, thiamethoxam) are quite effective, but must be applied before eggs are laid and damage detected. They kill the next generation of young larvae. Curative treatment of billbug grubs with currently available insecticides is difficult.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

UPDATED 12/16
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

A. CHLORANTRANILIPROLE

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete
MODE-OF-ACTION GROUP NUMBER: 28 COMMENTS: Applications should be made when overwintering adults are first observed, usually in April or May. Higher rates may be necessary when this window has passed.			
B. IMIDACLOPRID			
(Merit 75 WP)	3–4 teaspoons (0.148–0.19 oz)	12	Until dry
(Merit 75 WSP)	1.6 oz (1 packet/8,250–11,000 sq ft)	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Maximum of 1 application per year. Do not exceed 8.6 oz/acre per year (0.19 oz/1000 sq ft). Applications should not be made when turfgrass areas are waterlogged or soil is saturated with water. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
C. THIAMETHOXAM			
(Meridian)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D. CLOTHIANIDIN			
(Arena 50 WDG)	Label rates	12	Until dry
(Arena 0.25 G)	Label rates	12	When dust has settled.
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E. CARBARYL*			
(Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: For treatment of grubs later in the season. Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply sprays in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

NA Not applicable.

— Indicates use is not listed on label.

BLACK TURFGRASS ATAENIUS (12/16)

Scientific name: *Ataenius spretulus*

DESCRIPTION OF THE PEST

The adult black turfgrass ataenius beetle is 0.2 inch (5 mm) long, shining jet black, and has parallel grooves on the wing covers (elytra). Adults can be seen any time of day, especially on golf course greens and tees. Adult black turfgrass ataenius can easily be mistaken for another beetle, *Aphodius lividus* (not known to damage turf), which is slightly smaller and chocolate brown with straw-colored stripes near the center of the back and along the margin of the elytra.

Female ataenius adults burrow into the thatch and upper soil where they lay clutches of 11 or 12 eggs. Eggs hatch into scarab grubs, which can be distinguished from other white grubs by their small size, the scattered pattern of bristles on the last abdominal segment, and a pair of pads at the tip of the abdomen. At least two or three generations develop in California each year with up to five in the warmest part of the state. Adults are continuously active during warm months in inland areas. They probably overwinter in a reproductive dormancy.

SUSCEPTIBLE SPECIES

Although black turfgrass ataenius is common in many turfgrass areas, it is predominantly a pest of golf courses, especially during summer on highly stressed, cool-season grasses. It is also commonly found damaging bentgrass-rye mixtures and in annual bluegrass.

DAMAGE

The larval stage damages turfgrass by feeding on roots, resulting in irregular dead patches. The damaged area appears to be drought stressed, even where there is sufficient irrigation. Symptoms may resemble those of turfgrass root diseases such as summer patch, take-all patch, and Pythium root rot. Extensive root feeding sometimes allows the turf to be rolled back like a carpet. Digging by vertebrate predators, such as crows, raccoons, and skunks, is a common indication of high grub populations.

MANAGEMENT

Turfgrass can be managed to withstand low levels of black turfgrass ataenius by carefully scheduling irrigations and modifying mowing practices. If sampling indicates the population requires treatment, several treatment choices are available, including the use of parasitic nematodes.

Biological Control

Milky spore (*Paenibacillus* spp.) organisms have been detected infecting black turfgrass ataenius in California. Milky spore pathogens affecting ataenius do not include the one that controls Japanese beetles and are not commercially available. When black turfgrass ataenius is infected with milky spore diseases in other geographical areas, it undergoes a 3- or 4-year boom-and-bust cycle at a site, then the site becomes protected for several years from further damaging populations because of the milky spores presence in the soil, but this has not yet occurred in California. For short-term control, the pathogenic nematodes *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* are often effective.

Cultural Control

Improve root development as much as possible to allow turfgrass to withstand grub feeding by following recommended irrigation practices based on evapotranspiration needs of turfgrass, using small-tine or water injection aeration, and raising mowing height as feasible.

Monitoring and Treatment Decisions

The most effective insecticides, the neonicotinoids such as imidacloprid, provide best control if applied to just before adults lay eggs, generally before serious damage is seen. However, damaging infestations are not common and treatment is not regularly required, so this preventive approach is not recommended where an infestation is not expected. These materials can also be effective against very young grubs.

If irregular dead spots appear in turfgrass, sample for black turfgrass ataenius grubs or other insects. You can also sample about 2 weeks after adults are caught in black light traps. Use a cup cutter to sample for grubs underneath areas of turfgrass damage and in areas where grubs have been active in the past or are likely to occur (collars, wet spots, black layer spots). Grubs will be present at the thatch/soil interface. If there are more than four grubs per

cup cutter sample (or 40 grubs per square foot), treatment is necessary. Threshold levels are much lower for bentgrass grown in the desert region than the rest of the state because of the heat and drought stress. Apply liquid sprays or nematode applications to moist turfgrass and granules to dry turfgrass. Irrigate following application to move the material into the zone of larval feeding.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

UPDATED 12/16

The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

A. CHLORANTRANILIPROLE

(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete

MODE-OF-ACTION GROUP NUMBER: 28
COMMENTS: Applications should be made when overwintering adults are first observed, usually in April or May. Higher rates may be necessary when this window has passed.

B. IMIDACLOPRID

(Merit 75WP)	3–4 teaspoons	12	Until dry
(Merit 0.5G)	1.4–1.8 lb	0	0
(Merit 75WSP)	1.6 oz (1 packet/8,250–11,000 sq ft)	12	Until dry

MODE-OF-ACTION GROUP NUMBER[1]: 4A
COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Use in areas that have had severe infestations of black turfgrass ataenius in the past. Maximum of 1 application per year. Applications cannot exceed 8.6 oz/acre per year (0.19 oz/1000 sq ft). Applications should not be made when turfgrass areas are waterlogged or soil is saturated with water. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

C. CLOTHIANIDIN

(Arena 50 WDG)	Label rates	12	Until dry
(Arena 0.25 G)	Label rates	12	When dust has settled.

MODE-OF-ACTION GROUP NUMBER[1]: 4A
COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

D. HETERORHABDITIS BACTERIOPHORA — 25–35 million — NA — NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.
. . . or . . .
STEINERNEMA CARPOCAPSAE — 25 million — NA — NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.

E. ACEPHATE
(Orthene) — Label rates — 24 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1B
COMMENTS: Make two biweekly applications when larvae detected. For use on golf courses and sod farms only. Nontarget effects likely on other soil-dwelling organisms. Odorous. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

F. CARBARYL*
(Sevin SL) — Label rates — 12 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A

COMMENTS: For treatment of grubs later in the season. Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

** Apply sprays in 25 gal water/1000 sq ft.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

NA Not applicable.

CRANE FLIES (12/16)

Scientific names:
European Crane Fly: *Tipula paludosa*
Common Crane Fly: *Tipula oleracea*

DESCRIPTION OF THE PESTS

Adult crane flies emerge from the soil beneath turfgrass, pastures and other grassy areas in late summer and fall. The adults have very long legs and resemble large mosquitoes. Females mate and lay eggs in grass within 24 hours of emerging. Eggs hatch into small, brown, wormlike larvae that have very tough skin and are commonly referred to as "leatherjackets". The leatherjackets feed on the roots and crowns of clover and grass plants during the fall. They spend the winter as larvae in the soil; when the weather warms in spring, they resume feeding. During the day larvae mostly stay underground, but on damp, warm nights they come to the surface to feed on the aboveground parts of many plants. When mature, the larvae are about 1 to 1-1/2 inch long. Around mid-May they enter a nonfeeding pupal stage and remain just below the soil surface. In late summer, pupae wriggle to the surface and the adults emerge. There is one generation a year.

SUSCEPTIBLE SPECIES

In California crane flies have primarily been found at damaging levels in the Humboldt and Del Norte counties and do not appear to be a problem on turfgrass in warmer, inland areas. All cool-season turfgrass species appear to be susceptible.

DAMAGE

The larvae are the damaging stage of this pest. They feed on the roots, crowns, and aboveground portions of grass plants. Healthy, vigorous turfgrass can withstand low to moderate populations. Damage often becomes noticeable in March and April and appears as dying patches of turfgrass. Weeds may invade areas of dying turfgrass. Although the adults resemble mosquitoes, they do not bite or sting; it is believed that they feed primarily on plant nectar. Populations of crane fly larvae have been reduced by as much as 50% during the winter months and between March and May as a result of predators such as birds and predaceous ground beetles and other natural causes.

MANAGEMENT

A vigorously growing, well-maintained turfgrass can easily recover from the feeding of crane fly larvae, even when the populations are fairly high. Monitor for crane fly larvae if the turfgrass is exhibiting areas of poor growth. Adequate nitrogen fertilizer is essential.

Biological Control

Drenches with the nematode *Steinernema feltiae* may give up to 50% reduction if properly applied.

Cultural Control

Proper fertilization and irrigation are important factors in determining how much feeding by crane fly larvae the turfgrass can tolerate. Well-maintained turfgrass has been observed to withstand populations of crane fly larvae that averaged 40 per square foot, whereas unthrifty turfgrass may exhibit damage with as few as 15 larvae per square foot. Application of nitrogen in the spring may reduce damage. Provide better drainage for chronically wet areas and redue irrigation. Craneflies thrive in wet soils.

Growing turfgrass species that require full sun in shady areas can reduce plant vigor and promote survival of crane fly larvae. In areas of low sun, consider a turfgrass species that prefers shade or a groundcover.

Remove excess thatch; it provides an ideal habitat for crane fly larvae, which feed mostly just below the thatch. Aerify the soil to stimulate root development and improve the movement of water and nutrients into the soil. Reseed bare areas of turfgrass so that weeds do not invade.

Monitoring and Treatment Decisions

Monitor crane fly larvae in spring when the weather has warmed, generally in March. Samples can either be taken with a 4-inch diameter cup cutter or by digging up a 6" by 6" area of turfgrass about 1 to 2 inches deep. Larvae will usually be found at the base of the vegetative layer (thatch) or in the soil just beneath the plants. Pull apart the samples and count the number of crane fly larvae. If a 4-inch diameter cup cutter is used, multiply the

number of larvae in each core by 11.5 to get the number of larvae per square foot. If a 6" X 6" area is sampled, multiply the number of larvae by 4 to get the number of larvae per square foot. Sample three or four locations and determine the average number of larvae per sq. ft. If damaged areas of turfgrass are sampled, take the sample from the edge of damaged area and not from bare patches, where the larvae would no longer be present. Continue monitoring through April, if no damage is observed by then, no further action is needed.

Research has not been conducted in California on treatment thresholds, but in Washington, the treatment threshold is 25 to 50 larvae per square foot.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. CHLORANTRANILIPROLE			
(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete
MODE-OF-ACTION GROUP NUMBER: 28			
COMMENTS: Applications should be made when overwintering adults are first observed, usually in April or May. Higher rates may be necessary when this window has passed.			
B. CLOTHIANIDIN			
(Arena 50 WDG)	Label rates	12	Until dry
(Arena 0.25 G)	Label rates	12	When dust has settled.
MODE-OF-ACTION GROUP NUMBER[1]: 4A			
COMMENTS: Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
C. STEINERNEMA FELTIAE	25 million	NA	NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.			
D. CARBARYL*			
(Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Water or irrigate turf soon after treatment. Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

NA Not applicable.

— Indicates use is not listed on label.

CUTWORMS and ARMYWORMS (12/16)

Scientific names
Black cutworm: *Agrotis ipsilon*
Variegated cutworm: *Peridroma saucia*
Granulate cutworm: *Agrotis subterranea*
Armyworm: *Pseudaletia unipuncta*

DESCRIPTION OF THE PESTS

Cutworms and armyworms are larvae of heavy-bodied, night-flying moths in the family Noctuidae. The white or greenish eggs of these noctuids are laid in masses, darkening as they approach hatching. Larvae can grow up to 2 inches (5 cm) long and typically curl up and lie still when disturbed.

Although damage is similar, armyworms are distinct from cutworms in their behavior. While cutworms are usually solitary feeders, armyworm eggs are laid in masses and larvae will feed as a group. When populations are high and food is scarce, armyworms will move as a group, feeding indiscriminately on plants in their path. Variegated cutworms are also known to march like armyworms when populations are high.

SUSCEPTIBLE SPECIES

All turfgrass species.

DAMAGE

Cutworms and armyworms are active from mid-March to October. They feed on leaves and crowns and may cut off plants near the soil surface. Larvae feed at night and hide in the thatch layer or in a burrow in the soil during the day. Turfgrass may be closely clipped around aeration holes, which larvae commonly occupy. Damage appears as circular spots of dead grass or depressed spots. Armyworms, especially, prefer damp areas.

MANAGEMENT

Manage armyworms or cutworms by dethatching the turfgrass and ensuring that irrigation does not cause wet areas in the turf. When monitoring indicates a need to treat, treatment choices include parasitic nematodes and *Bacillus thuringiensis* (Bt).

Biological Control

Larvae are parasitized by braconid wasps (*Apanteles* spp.) and by tachinid flies. Birds also commonly feed on armyworms and cutworms. The extensive contact noctuid larvae have with soil or thatch makes *Steinernema carpocapsae* nematodes a valuable control measure.

Cultural Control

Remove thatch to eliminate much of the daytime resting habitat for larvae. Avoid wet areas by irrigating according to evapotranspiration needs of turfgrass, because armyworms prefer laying eggs in damp areas containing stressed plants.

Monitoring and Treatment Decisions

Threshold levels are five larvae per square yard. Conduct a drench test (see MONITORING AND TREATING INSECTS AND MITES) to determine the infestation level. Consider treatment when there are more than five larvae per square yard. Mow and irrigate the site before applying insecticide and do not mow or irrigate the turfgrass for at least 24 hours after treatment unless nematodes were applied, in which case apply a post-treatment irrigation. *Bacillus thuringiensis* subsp. *kurstaki* (Bt) is not as effective against cutworms and armyworms as for sod webworms and should only be used on younger larval stages (first and second instars). When Bt is applied, do not irrigate for 2 days after treatment.

Common name (Example trade names)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

UPDATED 12/16

The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

A. SPINOSAD
(Conserve SC) — Armyworms: 0.25–1.2 fl oz; Cutworms: 0.8–1.2 fl oz — 4 — Until dry

MODE-OF-ACTION GROUP NUMBER[1]: 5
COMMENTS: Use lower rate for control of light infestations of small larvae; the higher rate should be used for control of heavy infestations and large larvae. Delay watering or mowing of treated area for 12–48 hrs after treatment. Do not reapply within less than 7 days. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. BACILLUS THURINGIENSIS ssp. KURSTAKI
(various products) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 11A
COMMENTS: For young cutworm larvae. Apply to early instar larvae. Repeat application may be necessary. Breaks down rapidly in sunlight and washes readily off leaves. Do not irrigate for 2 days after treatment.

C. BACILLUS THURINGIENSIS ssp. AIZAWAI
(various products) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 11A
COMMENTS: For young armyworm larvae. Apply to early instar larvae. Repeat application may be necessary. Breaks down rapidly in sunlight and washes readily off leaves. Do not irrigate for 2 days after treatment.

D. STEINERNEMA CARPOCAPSAE — 25 million — NA — NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.

E. AZADIRACHTIN
(Azatrol, Neemix) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: un
COMMENTS: Most effective on young larvae. Can be used on both warm- and cool-season grasses.

F PYRETHRINS
(various products) — Label rates — See label — See label
MODE OF ACTION: 3A

G. CHLORANTRANILIPROLE
(Acelepryn) — Label rates — 4 — Until dry
(Acelepryn G) — Label rates — 4 — after application complete
MODE-OF-ACTION GROUP NUMBER: 28

H. CLOTHIANIDIN
(Arena 50 WDG) — Label rates — 12 — Until dry
(Arena 0.25 G) — Label rates — 12 — When dust has settled.

MODE-OF-ACTION GROUP NUMBER[1]: 4A
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

I. CARBARYL*
(Sevin) — 3 oz — 12 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A
COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

J. BIFENTHRIN
(Talstar) — Label rates — — — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A

Common name (Example trade names)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16 COMMENTS: Not for use on sod farms or in commercial seed production. May cause water quality issues. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply spray in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"= unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at *http://irac-online.org/.*

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

NA Not applicable.

— Indicates use is not listed on label.

DICHONDRA FLEA BEETLE (12/16)

Scientific name: *Chaetocnema repens*

DESCRIPTION OF THE PEST

Eggs are laid near the soil surface and require 3 days to hatch. The soil-dwelling larvae are white, with fine bristles and a light brown head capsule. Last (fourth) instar larvae are about 0.17 to 0.25 inch long. The white pupae are 0.05 inch long and are found in the same depths (up to 4 inches) in the soil as the larvae. Larvae require 22 to 25 days to complete development; pupation takes about 5 days. Adults are ovoid, about 0.06 inch long, and have greatly thickened hind femora for jumping. Newly emerged adults are white for 1 day, then turn a characteristic black color with a metallic reddish bronze tinge. The antennae, front, and middle legs are reddish yellow. Adults can be observed by passing a hand over affected dichondra. The disturbed adults will jump, some of them onto your hand or arm. Dichondra flea beetle overwinters as an adult.

SUSCEPTIBLE SPECIES

Dichondra and bermudagrass.

DAMAGE

Dichondra flea beetles seriously damage dichondra, causing many dichondra lawns to be replaced with grass turf. Larvae feed between May and October on small roots and the outsides of larger roots. This injury causes dichondra to wilt and die; often, large patches are affected. Adults feed on dichondra leaves, producing distinctive crescent marks on the upper surface. Severely skeletonized plants may wither; however, this symptom is most likely caused by larval root feeding. Larval populations can be assessed by placing turf soil cores in a Berlese funnel and extracting the larvae.

The dichondra flea beetle has also been found damaging common and hybrid bermudagrass in California. Symptoms include overall appearance of lack of water or fertilizer burn. First signs of damage appear in March and decrease in September as temperatures drop. Individual leaf blades have white linear banding along the length of the leaf blade. Occasionally the turf becomes bleached out in appearance.

MANAGEMENT

Treat for dichondra flea beetle if populations are high enough that damage may occur.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. ACEPHATE (Orthene Turf, Tree, and Ornamental Spray)	1–1.9 oz	24	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1B COMMENTS: For use on golf courses and sod farms only. Nontarget effects likely on other soil-dwelling organisms. Odorous. Up to 2.4 oz material/1000 sq. ft. can be used for black cutworm on turfgrass. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. DELTAMETHRIN (DeltaGard G)	2–3 lb	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Not for use on sod farms or in commercial seed production. For best results, irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and to dissolve the granules.			

** Apply in 25 gal water/1000 sq ft unless otherwise noted.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

FIERY SKIPPER (12/16)

Scientific name: *Hylephila phyleus*

DESCRIPTION OF THE PEST

Adult fiery skippers closely resemble butterflies but have a hooked knob at the end of their antennae. They have orange or orange-brown wings and are commonly seen feeding on lantana blossoms. Adult females glue hemispherical eggs singly to the underside of grass leaves. Newly hatch larvae notch leaves. As they grow, they consume entire leaves. The larva is about 1 inch long and has what appears to be an oversized black head, a narrowed "neck" followed by a dark thoracic shield, and a greenish brown body color with a granulated texture. Larvae spin silk shelters in the thatch from the third instar on, and are not readily seen unless flushed out with a drench test.

SUSCEPTIBLE SPECIES

Bermudagrass is preferred by fiery skippers, although they also feed on St. Augustinegrass, bentgrass, and occasionally other turfgrasses.

DAMAGE

Skipper larvae feed from May through September. Damage appears as a 1- or 2-inch diameter round spot from which all the grass has been eaten by a single larva. If there is a large population, then these spots will coalesce into dead patches. Usually damage appears on turfgrass planted near flower beds, where adult skippers feed.

MANAGEMENT

If skipper larvae are damaging turfgrass, dethatch the turfgrass to eliminate larval habitat. If monitoring indicates treatment is warranted, treatment choices include parasitic nematodes and *Bacillus thuringiensis* (Bt).

Biological Control

Larvae are attacked by parasitic braconid and ichneumonid wasps. The extensive soil or thatch contact of fiery skipper larvae may make *Steinernema carpocapsae* nematodes a valuable control measure, although this has not been tested. *Bacillus thuringiensis* subsp. *kurstaki* (Bt) may also be effective against fiery skipper, although more testing is needed to determine its efficacy for this purpose.

Monitoring and Treatment Decisions

Use the drench test to monitor this pest, see MONITORING AND TREATING INSECTS AND MITES. Five larvae per square yard on bentgrass greens and 15 per square yard in bermudagrass indicate treatment thresholds.

Mow the lawn and irrigate the site before applying insecticide, and do not mow or irrigate the turfgrass for at least 24 hours after treatment unless nematodes were applied, in which case apply a post-treatment irrigation. When Bt is applied, do not irrigate for 2 days after treatment.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. SPINOSAD			
(Conserve SC)	Label rates	4	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 5			
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. BACILLUS THURINGIENSIS ssp. KURSTAKI			
(various products)	Label rates	4	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 11A			
COMMENTS: Breaks down rapidly in sunlight and washes readily off leaves. Do not irrigate for 2 days after treatment.			

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
C. HETERORHABDITIS BACTERIOPHORA	25–35 million	NA	NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.			
. . . or . . .			
STEINERNEMA CARPOCAPSAE	25 million	NA	NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.			
D. AZADIRACHTIN			
(Azatrol, Neemix)	Label rates	4	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: un			
COMMENTS: Most effective on young larvae. Can be used on both warm- and cool-season grasses.			
E PYRETHRINS			
(various products)	Label rates	See label	
MODE-OF-ACTION: 3A			
F. CHLORANTRANILIPROLE			
(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete
MODE-OF-ACTION GROUP NUMBER: 28			
G. CLOTHIANIDIN			
(Arena 50 WDG)	Label rates	12	Until dry
(Arena 0.25 G)	Label rates	12	When dust has settled.
MODE-OF-ACTION GROUP NUMBER[1]: 4A			
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
H. CARBARYL*			
(Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"= unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

FRIT FLY (12/16)

Scientific name: *Oscinella frit*

DESCRIPTION OF THE PEST

Adult frit flies are slightly more than 0.062 inch long, shining black with small yellow markings on the legs. The eggs are pure white, 0.03 inch long, with a finely ridged surface. Mature larvae are 0.125-inch long, yellow, with black, curved mouth hooks. Pupae are yellow at first, then turn dark brown and are slightly less than 0.125 inch long.

The winter is passed in the larval stage in the stems of grasses. Pupation takes place in spring, and the first adults emerge about March. Eggs are laid on the leaves and leaf sheaths of grasses. Several larvae may occur in one plant. There are at least three broods, the activity of the last extending into October in warmer areas.

SUSCEPTIBLE SPECIES

All species of turfgrass are susceptible, but bentgrasses and bluegrasses seem to be the most susceptible to injury.

DAMAGE

Larvae tunnel in the stems near the surface of the soil, causing the upper portion of the plant to turn brown and die. Damage is most common on golf greens. Injury appears first on the collars of the greens and moves in toward the center. The high, or upper, sections are usually the first to show the symptoms. Greens with high organic matter content appear to be most susceptible.

MANAGEMENT

Look for small, black adult flies hovering close to the grass from mid to late morning. Look for the larvae in the stems near the ground level. A hand lens or dissecting microscope is useful in finding the very small larvae. Treatments are rarely needed unless damage is occurring.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. PERMETHRIN (Astro, etc.)	0.4–0.8 fl oz	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Apply using sufficient water to provide adequate coverage. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

LEAFHOPPERS (12/16)

Scientific names: *Draeculacephala minerva*, *Deltacephalus sonorus*, and others

DESCRIPTION OF THE PESTS

Adults are 0.12 to 0.25 inch long, wedge-shaped, active insects that jump and fly short distances when disturbed. Colors vary by species and are often mottled or speckled with whitish green, yellow, and brownish gray. Adults insert eggs into turfgrass leaves. Nymphs lack wings; their color varies with species. Disturbed nymphs have a characteristic habit of moving sideways or backwards. Generation time varies from 12 to 30 days, depending on species and temperature.

SUSCEPTIBLE SPECIES

All grasses can be affected by leafhopper feeding.

DAMAGE

Although leafhopper sightings are not uncommon on golf courses and lawns, severe injury usually occurs only with large leafhopper populations. Both nymphs and adults suck sap from the leaves, resulting in yellowing or bleaching. Affected turfgrass lose vigor and may die as a result of extended presence of high populations.

MANAGEMENT

Generally treatment for leafhoppers is not needed. Treat only if populations are high enough that damage is intolerable.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. ACEPHATE (Orthene Turf, Tree, and Ornamental Spray)	0.4 to 0.9 oz	24	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1B			
COMMENTS: For use on sod farms and golf courses only. Nontarget effects likely on other soil-dwelling organisms. Odorous. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. CARBARYL* (Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI)is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

MASKED CHAFERS (WHITE GRUBS) (12/16)

Scientific names: *Cyclocephala hirta, C. pasadenae*

DESCRIPTION OF THE PESTS

Masked chafers are large C-shaped beetle larvae that feed on roots of turfgrass plants. These grubs are white, up to 1 inch (2.5 cm) in length, with dark translucent dorsal stripes, brown head capsules and legs, and a characteristic pattern of bristles on the underside of the posterior end of the abdomen (the raster). Masked chafers have a scattering of bristles, while less commonly encountered May or June beetles have two parallel rows of bristles. Masked chafers are larger than black turfgrass ataenius grubs and have a slight constriction at the forward portion of the abdomen, which helps distinguish them. Adult beetles are golden brown, hairy on the underside of the thorax, and have a darker brown head. *Cyclocephala hirta* is common throughout California; *C. pasadenae* is found in southern California. Both species complete one generation per year overwintering as mature larvae, which form earthen cells in soil where they pupate. Adult males are attracted to lights at night, mostly from mid-June through July.

SUSCEPTIBLE SPECIES

All turfgrass species are susceptible to masked chafer damage. Damage is usually more serious on ryegrass and bluegrass turfgrasses, whereas fescues are somewhat less affected. Warm-season grasses tend to be the most tolerant of grub feeding.

DAMAGE

Masked chafer grubs feed on roots, resulting in irregular dead patches. Symptoms resemble drought stress and persist even where there is sufficient irrigation. Grub activity can cause the ground to feel spongy; extensive root feeding sometimes allows the turf to be rolled back like a carpet. Most damage usually takes place in late summer or early fall. Digging by vertebrate predators, such as crows, raccoons, skunks, and coyotes, is a common indication of high grub populations. Damage becomes most apparent in late summer or fall.

MANAGEMENT

For turfgrass infested with masked chafers, biological and cultural controls may help reduce their number. If monitoring indicates a need, treatment may be warranted. Commercially available parasitic nematodes are among the treatment options.

Biological Control

Tiphiid wasps are common parasites of masked chafers, but may not consistently be effective in reducing grub populations below damage thresholds. Milky spore (*Paenibacillus* spp.) organisms have been detected infecting masked chafers in California, but the milky spore pathogens infecting the larvae do not include the one that controls Japanese beetles and are not commercially available. *Heterorhabditis bacteriophora* are commercially available pathogenic nematodes that can effectively control masked chafers. *Steinernema carpocapsae* nematodes are not effective.

Cultural Control

Establishing warm-season grasses may reduce white grub damage. Although not a reliable control method, thorough spike-aeration of turf also kills significant portions of white grub populations when they are feeding close to the soil surface.

Monitoring and Treatment Decisions

Carefully dig around roots of grass to detect white grubs. If the infestation is heavy, the turf may be loose and easy to roll back like a carpet. For more information on monitoring, see MONITORING AND TREATING INSECTS AND MITES. Threshold levels on golf greens are low; if you detect more than one grub per square foot on greens, treatment should be undertaken. In other turfgrass settings, up to six grubs per square foot can usually be tolerated.

Proper timing for insecticide treatments for white grubs is difficult. The most effective insecticides (imidacloprid, thiomethoxam) are most effective when applied preventively when adults are laying eggs and before damage is seen in summer. These treatments are usually effective but only a small percentage of turf in California is infested with white grubs in any year and requires treatment. Alternatively treatments can be applied when damaging

levels of grubs are found later in the summer. Nematode treatments can be effective at this time. Other materials applied to control larvae include carbaryl.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. CHLORANTRANILIPROLE			
(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete
MODE-OF-ACTION GROUP NUMBER: 28 COMMENTS: Applications should be made when adults are first observed in late spring, usually in May and June. Higher rates may be necessary when this window has passed.			
B. IMIDACLOPRID			
(Merit 75 WP)	3–4 teaspoons (0.148–0.19 oz)	12	Until dry
(Merit 75 WSP)	1.6 oz (1 packet/8,250–11,000 sq ft)	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Maximum of 1 application per year. Applications cannot exceed 8.6 oz/acre per year (0.19 oz/1000 sq ft). Optimum control will be achieved when applications are made before egg hatch followed by sufficient irrigation or rainfall. Applications should not be made when turfgrass areas are waterlogged or soil is saturated with water. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
C. CLOTHIANIDIN			
(Arena)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Most effective if applied just before eggs laid. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D. THIAMETHOXAM			
(Meridian)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 4A COMMENTS: Most effective if applied just before eggs laid. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E. HETERORHABDITIS BACTERIOPHORA	25 million	NA	NA
COMMENTS: Apply in late spring or early summer before adults emerge, or early fall when most chafers are in the susceptible stages. Irrigate before and after applying nematodes. Store nematodes before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during cool time of day in hot areas.			
F. CARBARYL*			
(Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: For treatment of grubs. Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with

chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

NA Not applicable.

— Indicates use is not listed on label.

Current chemical control options are most effective against early instar larvae (less than 0.5 inch long). Grubs may take up to 10 days to die following contact with an insecticide, so wait at least this long to evaluate insecticide efficacy. Adult activity generally occurs during the period from mid-June to July. Because applied insecticides bind to the leaf blades and thatch, remove thatch before and irrigate immediately following application to obtain good results.

PLANT BUGS (12/16)

Scientific names
False chinch bug: *Nysius* spp.
Weed bug: *Arrhyssus crassus*
White-marked fleahopper: *Spanogonicus albofasciatus*

DESCRIPTION OF THE PESTS

Plant bugs are sucking insects. The anterior portion of their forewings is leathery and the posterior portion is membranous. The false chinch bug and weed bug are occasional nuisance pests. Both species are a pale gray color as adults and nymphs and feed on weedy hosts; the false chinch bug is just under 0.25 inch, while the weed bug is just over 0.25 inch. When winter rains permit heavy growth of vegetation, these bug populations build up to large numbers. Later, as the vegetation dries down, the bugs migrate from the wild hosts and invade residential areas, including lawns and houses.

White-marked fleahopper adults are about 0.125 inch long, blackish or grayish, and have white markings on the wings, which are folded over the back. Their long antennae, white markings, larger size, and sucking mouthparts distinguish them from flea beetles. Fleahoppers can be observed by running your hand over the turfgrass or dichondra lawn. If they are present, they will hop about; some will land on the hand or sidewalks where they can be observed more readily.

SUSCEPTIBLE SPECIES

All turfgrass species and dichondra.

DAMAGE

Outbreaks of plant bugs are not common, but when they do occur, they can be damaging to turfgrass. All species of plant bugs feed via sucking mouthparts, so damaging populations can be expected to cause yellowing and stunting of the turf. Turfgrass is sometimes treated to prevent false chinch bugs and weed bugs from migrating into dwellings.

MANAGEMENT

Treat for plant bugs if populations are high enough that damage may occur.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. ACEPHATE (Orthene Turf, Tree, and Ornamental Spray)	1.2–2.4 oz	24	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1B COMMENTS: For use on golf courses and sod farms only. Nontarget effects likely on other soil-dwelling organisms. Odorous. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
B. CARBARYL* (Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
C. BIFENTHRIN (Talstar)	Label rates	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Not for use on sod farms or in commercial seed production. May cause water quality issues. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
D. CYFLUTHRIN (Tempo 20WP)*	0.2468 oz (7 grams)	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A COMMENTS: Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			

** Apply in 25 gal water/1000 sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their Website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

RED IMPORTED FIRE ANT (9/09)

Scientific name: *Solenopsis invicta*

DESCRIPTION OF THE PEST

Fire ants are characterized by having a -segmented petiole (the narrow waist between the thorax and abdomen), 10-segmented antennae with a 2-segment club, and a stinger. There are two native fire ant species likely to be encountered in California that can be confused with the red imported fire ant. The more common one, the southern fire ant (*Solenopsis xyloni*) is 2.5 to 4.5 mm in length and found in coastal and inland regions. It is very similar in appearance to the red imported fire ant. The southern fire ant differs from the red imported fire ant in that it is bicolored, with a reddish head and thorax and a dark brown abdomen. By contrast, the red imported fire ant is an almost uniform dark reddish-brown and 3 to 6 mm long. Both species have workers of mixed sizes.

Red imported fire ant mounds are frequently built up into domes, while the southern fire ant mounds are irregular craters. Mounds produced by red imported fire ant can reach 10 to 12 inches in height, however the size of mounds will vary with soil types, and mounds may be absent. A characteristic difference between these species is the aggressiveness of the workers. Although they will both sting, the ferocity of the red imported fire ant is notable. Any object touching their mound is immediately attacked and stung, and the workers will quickly run up a stick that touches the mound. It is still uncertain whether the red imported fire ant colonies in California have one or multiple queens per colony. This could have a significant impact on the selection of treatment strategies.

DAMAGE

Red imported fire ant can chew on soft plant tissue and growing buds. Their stinging behavior can be hazardous to people and pets. Their sting is noxious and produces a pustule on the skin that can scar if it gets infected. They can clog irrigation lines and short-circuit electrical systems.

MANAGEMENT

Although red imported fire ants are not present in all areas of California, they are a serious pest and are subject to quarantine regulations. In Southern California, state and federal officials have placed Orange County and portions of Los Angeles County and Riverside County under quarantine that limits the movement of articles including plants and soil. The California Department of Food and Agriculture (CDFA) has established the Red Imported Fire Ant hotline (1-888-4FIREANT or 1-888-434-7326) to report any suspected occurrence of red imported fire ant in California.

Treatment

Bait products are available for controlling red imported fire ants in areas where they are established. See the Fire Ant Pest Note for more information (*available online*). Contact CDFA or your county Agricultural Commissioner's office for information on approved treatments. RIFA Hotline 1-888-4FIREANT (1-888-434-7326).

SOD WEBWORMS (12/16)

Scientific names
Lucerne moth: *Nomophila noctuella*
Western lawn moth: *Tehama bonifatella*
Sperry's lawn moth: *Crambus sperryellus*

DESCRIPTION OF THE PESTS

Adult sod webworms, called lawn moths, are typical snout moths: they have sensory appendages called labial palps that extend in front of the head. The moth holds its wings close to and over its body at rest, giving it a slender appearance. When disturbed, the moth makes a short flight close to the grass. At night, these moths drop their eggs indiscriminately on to turf. The creamy larvae have a distinctive double row of brown or black spots down their backs, located at the base of long bristles. The Lucerne moth larva is somewhat larger than the other sod webworm larvae. During the day larvae reside in silk-lined burrows, writhing when disturbed. At night they emerge to feed.

SUSCEPTIBLE SPECIES

Bluegrasses and bentgrasses often suffer the most damage, while perennial ryegrasses and turf-type tall fescues infected with endophytes (symbiotic fungi) and warm-season turfgrasses are more resistant.

DAMAGE

First instar sod webworm larvae are leaf skeletonizers. Later instars notch or cut off leaf blades and pull them into the burrow. Heavily infested turf (more than 100/sq. yd.) quickly appears moth eaten, with irregular patches of brown grass or bare areas. Significant damage can occur on drought-affected bluegrass and on bentgrass green and tee areas. Lucerne moths are primarily a problem where clover and dichondra are mixed with turfgrass.

MANAGEMENT

When sod webworms are present, dethatching the turfgrass may help. Monitor to determine if treatment is needed. Treatment choices include parasitic nematodes and *Bacillus thuringiensis* (Bt).

Biological Control

Natural enemies in California include a parasitic tachinid fly and two parasitic braconid wasps, along with earwig, rove beetle, robber fly, paper wasp, ant, and vertebrate predators. The extensive soil or thatch contact of sod webworms makes *Steinernema carpocapsae* nematodes a valuable control measure. *Bacillus thuringiensis* ssp. *kurstaki* (Bt), a microbial insecticide, can be used but it breaks down rapidly in sunlight, washes readily off leaves, and is ineffective against late instar larvae.

Cultural Control

Thatch removal can assist in removing sod webworm habitat, although larvae do not require a thatch layer to be present in very high numbers. Control of clover and dichondra may help minimize damage. Damage is usually not noticeable in turf mowed at heights above 2.5 inches.

Monitoring and Treatment Decisions

Monitor for these pests from June to early October. Consider treating only when a drench test (see section on MONITORING AND TREATING INSECTS AND MITES) indicates there are more than 5 larvae per square yard on stressed greens or 15 larvae per square yard in other situations. If Bt is used, apply it when there are predominantly early instar larvae. Other materials are also most effective on small larvae but will kill larger ones more effectively.

Mow and irrigate the site before applying insecticide and do not mow or irrigate the turfgrass for at least 24 hours after treatment unless nematodes were applied, in which case apply a post-treatment irrigation. When Bt is applied, do not irrigate for 2 days after treatment.

Common name (Example trade name)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

UPDATED 12/16

The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

A. SPINOSAD
(Conserve) SC — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 5
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

B. BACILLUS THURINGIENSIS ssp. KURSTAKI
(various products) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 11A
COMMENTS: For young cutworm larvae. Apply to early instar larvae. Repeat application may be necessary. Breaks down rapidly in sunlight and washes readily off leaves. Do not irrigate for 2 days after treatment.

C. BACILLUS THURINGIENSIS ssp. AIZAWAI
(various products) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 11A
COMMENTS: For young armyworm larvae. Apply to early instar larvae. Repeat application may be necessary. Breaks down rapidly in sunlight and washes readily off leaves. Do not irrigate for 2 days after treatment.

D. STEINERNEMA CARPOCAPSAE — 25 million — NA — NA
COMMENTS: Store nematodes properly before use as directed. Apply to warm, moist, but not soggy soil. Several irrigations may be needed during 2 weeks after application to keep soil moist. Apply during the coolest time of day in hot areas.

E. AZADIRACHTIN
(Azatrol, Neemix) — Label rates — 4 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: un
COMMENTS: Most effective on young larvae. Can be used on both warm- and cool-season grasses.

F PYRETHRINS
(various products) — Label rates — See label — See label
MODE-OF-ACTION: 3A

G. CHLORANTRANILIPROLE
(Acelepryn) — Label Rates — 4 — Until dry
(Acelepryn G) — Label Rates — 4 — After application complete
MODE-OF-ACTION GROUP NUMBER: 28

H. CLOTHIANIDIN
(Arena 50 WDG) — Label rates — 12 — Until dry
(Arena 0.25 G) — Label rates — 12 — When dust has settled.
MODE-OF-ACTION GROUP NUMBER[1]: 4A
COMMENTS: Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

I. CARBARYL*
(Sevin SL) — Label rates — 12 — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A
COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

J. BIFENTHRIN
(Talstar) — Label rates — — — Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A
COMMENTS: Not for use on sod farms or in commercial seed production. May cause water quality issues. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.

** Apply in 25 gal water/1000sq ft.
* Permit required from county agricultural commissioner for purchase or use.
1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers ("un"=unknown or uncertain mode of action) are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at *http://irac-online.org/*.
‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.
NA Not applicable.
— Indicates use is not listed on label.

SOUTHERN CHINCH BUG (12/16)

Scientific name: *Blissus insularis*

DESCRIPTION OF THE PEST

Southern chinch bug adults are black with whitish wings that fold flat over their body. They are about 0.125 inch (0.3 cm) long. Both long- and short-winged adult forms may be present. Early instar nymphs are bright red but darken to black by the last instar. There are several generations a year, with all life stages present during summer; populations tend to be highest when temperatures are above 90° F. All life stages usually reside in the turfgrass crown and the thatch, but can also be observed at the border between damaged and healthy grass. Big-eyed bugs, which are beneficial predators, are similar in appearance to chinch bugs but their large eyes, which are the widest part of their body, distinguish them from chinch bugs.

SUSCEPTIBLE SPECIES

Although bermudagrass, buffalograss, and zoysiagrass are fed upon, only St. Augustinegrass is seriously damaged in California.

DAMAGE

Chinch bugs are active from April through October, especially in full sun. Southern chinch bugs suck sap from nodes and crown of the turfgrass. Yellowish to brownish patches result.

MANAGEMENT

When southern chinch bug occurs in turfgrass, decrease fertilizer rates and maintain adequate moisture. Usually only St. Augustinegrass is significantly damaged by this pest. Treatment may be required if monitoring indicates a need.

Biological Control

Big-eyed bugs, ants, and the fungal insect pathogen *Beauveria bassiana* are the most important natural enemies of chinch bugs. Maintaining moist conditions favors development of *Beauveria*.

Cultural Control

If St. Augustinegrass is desirable, select resistant varieties such as Floralawn, Floratam, or FX-10. Thatch removal is important for eliminating conditions favorable for chinch bug survival. Applying the low end of recommended nitrogen slows chinch bug reproduction. Maintaining adequate moisture will increase the tolerance to chinch bug feeding and promotes beneficial fungi that attach chinch bugs.

Monitoring and Treatment Decisions

Use the flotation method or drench test to determine chinch bug presence and population level. For the flotation method, take a 6-inch diameter coffee can, remove top and bottom, and set it 2 to 3 inches into the turfgrass. Fill it with water and wait for 5 to 10 minutes for bugs to float to the surface. The drench test is described in the section MONITORING AND TREATING INSECTS AND MITES. Treat when combined nymph and adult counts average at least 3 per coffee can sample, or 135 per square yard. Mow the lawn and irrigate before treating. After treatment, do not mow or irrigate for at least 24 hours.

Common name (Example trade names)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least harmful to natural enemies, honey beesand the environment are at the top of the table. When choosing a pesticide, consider information relating to air and water quality, resistance management, and the pesticide's properties and application timing. Not all registered pesticides are listed. Always read the label of the product being used.			
A. CHLORANTRANILIPROLE			
(Acelepryn)	Label Rates	4	Until dry
(Acelepryn G)	Label Rates	4	After application complete
MODE-OF-ACTION GROUP NUMBER: 28			

Common name (Example trade names)	Amount per 1000 sq ft**	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
COMMENTS: Make applications when bugs are first encountered and before eggs hatch.			
B. CLOTHIANIDIN			
(Arena 50 WDG)	Label rates	12	Until dry
(Arena 0.25 G)	Label rates	12	When dust has settled.
MODE-OF-ACTION GROUP NUMBER: 4A			
COMMENTS: Make applications when bugs are first encountered and before eggs hatch. Toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
C. ACEPHATE			
(Orthene Turf, Tree, and Ornamental Spray)	0.9–1.1 oz	24	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1B			
COMMENTS: For use on golf courses and sod farms only. Nontarget effects likely on other soil-dwelling organisms. Odorous. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
D. CARBARYL			
(Sevin SL)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 1A			
COMMENTS: Nontarget effects likely on other soil-dwelling organisms. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
E. CYFLUTHRIN			
(Tempo 20WP)*	0.176 oz (5 grams)	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
F. DELTAMETHRIN			
(DeltaGard G)	2–3 lb	—	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Not for use on sod farms or in commercial seed production. For best results, irrigate with an adequate quantity of water to thoroughly moisten grass and thatch and to dissolve the granules.			
G. PERMETHRIN			
(Astro, etc.)	0.4–0.8 fl oz	12	Until dry
MODE-OF-ACTION GROUP NUMBER[1]: 3A			
COMMENTS: Apply using sufficient water to provide adequate coverage. Highly toxic to bees; do not spray directly or allow to drift onto blooming crops or weeds where bees are foraging.			
H. BEAUVARIA BASSIANA			
(BotaniGard, Mycotrol)	Label rates	4	4

** Apply in 25 gal water/1000sq ft.

* Permit required from county agricultural commissioner for purchase or use.

1 Rotate chemicals with a different mode-of-action group number, and do not use products with the same mode-of-action group number more than twice per season to help prevent the development of resistance. For example, the organophosphates have a group number of 1B; chemicals with a 1B group number should be alternated with chemicals that have a group number other than 1B. Mode-of-action group numbers are assigned by IRAC (Insecticide Resistance Action Committee). For additional information, see their website at http://irac-online.org/.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

Diseases

(Section reviewed 7/09)

GENERAL PROPERTIES and USE OF FUNGICIDES (9/09)

The fungicide products mentioned in this section are registered for use on turfgrass in California, but many have not been evaluated by the University of California for their effectiveness in controlling turfgrass diseases. The fungicides are listed alphabetically in the treatment tables and not necessarily in the order of effectiveness. In general, use fungicides only on golf and bowling greens and other high maintenance turfgrasses. For best results, use fungicides preventively based on history of previous diseases and when conditions are conducive to disease development or when the disease is first visible. Accurate identification of a disease is critical to choosing the best fungicide. Read and follow fungicide label recommendations carefully for rate recommendations, which usually vary based on the severity of the disease and whether the treatment is preventive or curative.

Turfgrass areas such as landscape areas and parks only rarely require fungicide applications. Good cultural practices including proper turf species selection, appropriate use of fertilizer and irrigation will prevent serious damage in most turfgrass areas.

To help prevent the development of resistance to a pesticide, rotate pesticides with different mode-of-action group numbers. These numbers are listed with each pesticide in the treatment tables throughout this guideline.

Common name (Example trade names)	Chemical class	Activity	Mode-of-action (FRAC Group No.[1])	Resistance potential	Comments
azoxystrobin (Heritage)	QoI[2]	systemic	single-site (11)	high[4]	
captan (Captan)	phthalimide	contact	multi-site (M4)	low	highly toxic to bees
chlorothalonil (Concorde, Daconil)	chloronitrile	contact	multi-site (M5)	low	
fosetyl-al (Aliette, Prodigy, Chipco Signature)	phosphonate	systemic	multi-site (33)	low	
fludioxonil (Medallion)	phenylpyrrole	contact	few to multi-site (12)	medium	
flutolanil (Prostar)	carboxamide	—	multi-site (7)	medium	
iprodione (Chipco 26019)	dicarboximide	systemic	multi-site (2)	low	
mancozeb (Fore, Dithane M-45)	carbamate (EBDC)[5]	contact	multi-site (M3)	low	
mefenoxam (Subdue Maxx, Apron)	phenylamide	systemic	single-site (4)	high[4]	
myclobutanil (Eagle)	DMI[3]-triazole	systemic[6]	single-site (3)	high	
PCNB (Turfcide)	aromatic hydrocarbon	slight systemic	single-site (14)	medium	
propiconazole (Banner Maxx)	DMI[3]-triazole	systemic[6]	single-site (3)	high	
sulfur	inorganic	contact	multi-site (M2)	low	
thiophanate-methyl (Fungo Flo)	benzimidazole	systemic	single-site (1)	high	
triadimefon (Bayleton)	DMI[3]-triazole	systemic[6]	single-site (3)	high	
trifloxystrobin (Compass)	QoI[2]	systemic[6]	single-site (11)	high[4]	
vinclozolin (Curalan, Touche)	dicarboximide	systemic (local)	multi-site (2)	low	

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

2 QoI = quinone outside inhibitors

3 DMI = demethylation inhibitors

4 Resistance has been found in California for certain fungicides with a single-site mode of action. To reduce the risk of resistance development, take the mode of action into account when choosing a fungicide. At the beginning of a treatment program, use a fungicide with a multi-site mode of action; for subsequent applications rotate or mix fungicides with different mode-of-action FRAC numbers. Use labeled rates (preferably the upper range) of the single-site fungicides, and limit the total number of applications/season.

5 EBDC = ethylene bisdithiocarbamate

6 Generally considered to have systemic action based on performance data but has not been proven experimentally.

ANTHRACNOSE (12/16)

Pathogen: *Colletotrichum graminicola*

DESCRIPTION OF THE DISEASE

There are two types of anthracnose symptoms, a basal rot that occurs in cool, wet weather in spring and early summer, and a foliar blight that occurs under periods of heat and water stress. The foliar blight is most common in California; the basal rot anthracnose has not been reported in California.

For foliar blight symptoms, the older leaves are often attacked first, with reddish, brown-to-brown lesions that turn a pale tan color.

For basal rot, dark infection mats are often visible on the lower leaf sheaths and diseased crowns are often black and necrotic. Leaves are often yellow-orange.

In both cases, the fungus can produce fruiting structures (acervuli) that have fine black hair-like projections (setae) and are filled with small, crescent-shaped spores.

SUSCEPTIBLE TURFGRASSES

Anthracnose is most severe on annual bluegrass, *Poa annua*; it also occurs on Kentucky bluegrass, *P. pratensis*. Other species are only rarely affected by this disease in California.

CONDITIONS FAVORING DISEASE

Basal rot anthracnose is favored by cool, wet conditions (50 to 60° F) while the foliar blight is favored by higher temperatures (80 to 95° F). Both basal rot and foliar anthracnose development are favored by low soil fertility, high compaction, and high soil salinity. Extended periods of leaf wetness contribute to the development of the disease, as do practices that cause mechanical damage to the turf (top dressing and verticutting).

MANAGEMENT

Anthracnose is best managed by proper cultural practices. Fungicides should be used primarily on golf course greens and other intensively managed turf.

Cultural Control

Apply adequately balanced nutrients as necessary, concentrating on potassium and phosphorus. On golf course greens, fertilize with low rates of nitrogen (0.1–0.2 lb/1000 sq. ft.) monthly, especially during late spring and through the summer. Avoid fertilizing during periods of high temperatures (over 80° F).

Irrigate deeply and infrequently based on evapotranspiration needs of turfgrass. Allow leaves to dry between irrigations. Irrigate early in the morning rather than during late afternoon or evening. Lightly water (syringe) golf greens during the day to reduce heat and drought stress.

Reduce compaction through mechanical aerification in fall and spring. Increase mowing heights to reduce stress on affected turf. Increase air movement and reduce shading by selective pruning of trees and landscape that block air movement or light the grass. Periodically irrigate golf course greens heavily to leach salts if salinity is a problem.

Treatment Decisions

Fungicides are most effective when used preventively. For areas where anthracnose is common, begin applications when the soil temperature rises above 65ºF (mid to late spring) to reduce the severity of initial epidemics.

Strains of the anthracnose pathogen resistant to both QoI (Group 11) and benzimidazole (Group 1) fungicides have been documented in California. If control by fungicides from either mode-of-action Group has been ineffective in the past year, switch to a fungicide with a different group number or try tank mixing with a multi-site fungicide such as chlorothalanil.

Repeated applications of fungicides with the same group number for summer patch control may contribute to the development of fungicide resistance in anthracnose because both diseases tend to occur at the same time in the

season. Practice resistance management strategies for both diseases at the same time by alternating chemicals with different mode-of-action group numbers.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. CHLOROTHALONIL (Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
C. MYCLOBUTANIL (Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
D. PROPICONAZOLE (Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
E. THIOPHANATE-METHYL (Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
F. TRIADIMEFON (Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
G. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

CURVULARIA BLIGHT (12/16)

Pathogen: *Curvularia* spp.

DESCRIPTION OF THE DISEASE

Curvularia blight causes thinning out and decline of the grass; irregular patches and streaks may also occur. Leaves yellow and then become brown from the leaf tip down. Leaf spots can occur with symptoms most severe on older, senescing leaves. Roots, stolons and rhizomes may also become infected. A fine, grey layer of mycelia may cover infected tissues, and there is often an abundance of sporulation from infected and dead tissue. Spores are borne on the mycelia and no enclosed fruiting structures are formed.

SUSCEPTIBLE TURFGRASSES

Annual bluegrass, bermudagrass, bentgrass, and fescue are susceptible to curvularia blight.

CONDITIONS FAVORING DISEASE

The pathogen invades grasses through cut tips of leaves and is favored by high temperatures and adverse growing conditions. This is primarily a stress pathogen that attacks low fertility and heat and drought stressed plants. Damage often occurs when temperatures are 85° F or higher.

MANAGEMENT

To prevent conditions that can lead to the development of curvularia blight, avoid both overwatering and drought stress by irrigating according to evapotranspiration needs of the turfgrass. Fertilize to promote moderate growth. Maintain as high a mowing height as possible and control thatch. Avoid planting shade trees in the surrounding area. Fungicides may be warranted on golf greens during long periods of high temperatures.

Cultural Control

Cultural practices can be important in preventing development of this disease. Apply the correct amount of fertilizer, reduce soil compaction, provide good soil drainage, and manage the thatch layer to keep it under 0.5 inches in thickness.

Treatment Decisions

There is little fungicide efficacy data available for the control of curvularia diseases in California. Both chlorothalanil and iprodione have been shown to be effective in other states.

	Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16				
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.				
A.	CHLOROTHALONIL (Daconil Action) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)	Label rates	12	Until dry
B.	IPRODIONE (Chipco 26019) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)	4–8 fl oz/1000 sq ft	See label	Until dry

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

DOLLAR SPOT (12/16)

Pathogens: *Sclerotinia homeocarpa*, *Lanzia* sp., and *Moellerodiscus* sp.

DESCRIPTION OF THE DISEASE

Dollar spot affects small, circular areas of turf, about 1 to 5 inches in diameter. Spots may merge to form large, irregular areas. Leaves appear water-soaked initially, then brown and often exhibit a reddish band extending across the leaf. Lesions on leaves often have a distinctive "hourglass" shape with necrosis on the outer edges of the leaf blade and healthy tissue in the middle. Fine, white, cobwebby hyphae (fungal threads) may be seen in early morning. The fungus survives as mycelia or stromata (dark, tiny, hard, resting bodies) on plants or in plant debris during periods of unfavorable weather conditions.

SUSCEPTIBLE TURFGRASSES

Bentgrass, bermudagrass, fescue, ryegrass and Kentucky annual bluegrasses can be affected, but closely mowed grasses of any of these species are most susceptible to the disease.

CONDITIONS FAVORING DISEASE

Dollar spot is most common during the spring and fall months in California, especially on annual bluegrass, Kentucky bluegrass, and creeping bentgrass used in coastal plantings. Disease development is favored by moderate temperatures (60° to 80° F) with high relative humidity. Excessive leaf wetness and fog contribute to disease development as do water stress and excess thatch development. Dollar spot is primarily a problem on golf courses and lawn bowling greens.

MANAGEMENT

Proper fertilization and irrigation as well as top dressing with compost are important in preventing the development of dollar spot. Fungicides may be necessary to provide control if the disease develops.

Cultural Control

Turfgrass deficient in nitrogen tends to develop more dollar spot than turfgrass adequately fertilized. Apply recommended amounts of nitrogen and maintain adequate air circulation. Keep thatch to a minimum. Irrigate based on evapotranspiration needs of the turfgrass to a depth of 4 to 6 inches, but avoid creating drought stress by extending the interval between irrigations too long. Raise the mowing heights as much as possible.

Avoid prolonged leaf wetness by irrigating in the morning or early afternoon rather than later in the day. Remove morning dew with a light irrigation or poling. Poling involves dragging the surface of the turf with a long bamboo or plastic pole, or with an irrigation hose, to remove the dew from the grass leaves. Some varieties of creeping bentgrass show higher levels of tolerance to this disease than others. Varieties such as Putter, Emerald, Forbes 80-12, SR-1020, Penneagale, Penncross, Century and Crenshaw are quite susceptible to dollar spot, while varieties such as L-93, A-1, Providence and Pennlinks have shown tolerance to this disease.

Adding composted top dressings has been shown to reduce the incidence and severity of dollar spot, allowing a reduction in the frequency and/or application rates of fungicides.

Treatment Decisions

Apply fungicides when environmental conditions favor the development of the disease, or when the first symptoms are detected. Apply until environmental conditions are no longer favorable for the disease.

Resistance to benzimidazole (Group 1) and DMI (Group 3) fungicides has been reported in a number of locations in the United States. Benzimidazole resistance usually manifests as a loss of acceptable control with the fungicide, while DMI resistance is seen as a need for higher application rates and shorter application intervals. Alternate the use of fungicides with different mode-of-action group numbers to slow the development of resistance to any one given fungicide.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. CHLOROTHALONIL			
(Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
B. IPRODIONE			
(Chipco 26019)	3–4 fl oz/1000 sq ft.	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
C. MYCLOBUTANIL			
(Eagle 20EW)	Label rates	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
D. PROPICONAZOLE			
(Banner Maxx)	1–2 fl oz/1000 sq ft.	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
E. SULFUR			
(Sulfur 6L)	1.33–7.33 gal/acre	24	Until dry
(Sulfur DF)	10–55 lb/acre	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M2)			
F. THIOPHANATE-METHYL			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
G. TRIADIMEFON			
(Bayleton 50 Turf and Ornamental)	Label Rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H. TRIFLOXYSTROBIN			
(Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
I. VINCLOZOLIN			
(Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

FAIRY RING (12/16)

Pathogens: *Agrocybe pediades*, *Marasmius oreades*, *Lepiota* spp., etc.

DESCRIPTION OF THE DISEASE

Fairy ring is caused by a number of species of mushroom-forming fungi including many basidiomycetes in the order Agaricales. For example, *Lepiota* spp. are common in southern California, *Marasmius oreades* has been found in central and northern California, and *Agrocybe pediades* occurs in both southern and northern California. Many of these fungi are poisonous and must not be eaten.

Fairy rings are circular or semi-circular and can range in size from a few centimeters up to many meters in diameter. Symptoms can be variable, depending on the species of fungi, and include: 1) dark green rings with no dead turf; 2) dark green rings with a thin ring of dying or dead turf inside or outside the green ring; 3) rings of dying and dead turf with a hardened hydrophobic layer of soil that is difficult to irrigate; and 4) rings of mushrooms without a visible effect on the turf. Weeds commonly invade infested areas.

There are two types of fairy rings, edaphic (non-superficial) or lectophilic (superficial). Edaphic rings are generally formed by fungi that inhabit the soil underneath the turf. These frequently cause a hardened hydrophobic layer of soil above the areas of their active growth that prevents water penetration into the soil and often causes plant death. Rings of dead turf are frequently associated with this type.

Lectophilic rings are caused by fungi that inhabit the thatch layer and decomposed plant debris, litter, and old thatch. These rings are characterized by a slight depression of the affected areas surrounded by dark green rings of turfgrass where the fungi are breaking down plant material and releasing nitrogen. A hard hydrophobic soil layer is not associated with this type of fairy ring.

The fungus survives as a white mass of mycelia in the soil or thatch layer, or can be spread by spores dispersed by the mushrooms produced by the rings. In some cases, rings or mushrooms can appear in the turfgrass and cause no apparent damage.

SUSCEPTIBLE TURFGRASSES

All grasses are susceptible to fairy ring.

CONDITIONS FAVORING DISEASE

A dense thatch layer contributes to the availability of undecomposed matter, as does the addition of composts or other organic material that have not been fully decomposed. Also, turfgrass growing in low fertility soils with insufficient irrigation appears to suffer more damage from fairy rings than turfgrass with adequate fertility and irrigation.

MANAGEMENT

A turfgrass management program that provides proper fertilization and irrigation along with regular dethatching of the turfgrass will help prevent the development of this disease. Fungicide treatment or soil removal may be necessary if fairy ring becomes a problem.

Cultural Control

To avoid or reduce symptoms, apply adequate nitrogen and water. Symptoms of superficial rings can be masked by nitrogen applications. If fairy rings are present, aeration followed by heavy watering for several weeks may help reduce symptoms; soil wetting agents may improve water penetration. Proper thatch management and regular dethatching can contribute to a reduction in the disease. Fairy ring can be eliminated by removing the turf and root zone with the soil containing the white, cottony, mycelial mass. If fairy ring symptoms consist only of mushrooms and there is no zone of dark green grass, the mushrooms can be raked off and disposed of. While this will not weaken or control the fungus, it will improve the turf's appearance.

Treatment Decisions

Fungicide applications of azoxystrobin appear to provide good control of the disease when used properly. Flutolanil applications provide some suppression; control may be improved if applications are used in conjunction with cultural practices.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. FLUTOLANIL (Prostar WG)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)			

* Permit required from county agricultural commissioner for purchase or use.

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

FUSARIUM BLIGHT (12/16)

Pathogens: *Fusarium culmorum, F. tricinctum*

DESCRIPTION OF THE DISEASE

Fusarium blight first appears as small, circular, grayish green areas, ranging from a few inches up to a foot in diameter. Some plants in the center of the circles may survive, giving them a frog eye or donut appearance. The crown or basal area of the dead stems is affected with a reddish rot and is hard and tough. At times, a pink layer of the fungus can be seen near the soil line. The dead foliage appears bleached. The fungus survives as mycelia in plant debris and plants killed by previous infections, or as thick walled resting spores (chlamydospores) in the thatch and soil.

SUSCEPTIBLE TURFGRASSES

Fusarium blight can affect a number of cool-season grasses grown in warm weather conditions including bentgrasses, red fescue, tall fescue, perennial ryegrass and centipedegrass, but is most severe on Kentucky bluegrass. For Kentucky bluegrass, the most susceptible cultivars are Park, Campus, Fylking, and Nugget. A-34, Baron, Merion, Victa, Windsor, and the newer cultivars such as Adelphi, Bonnieblue, Geronimo, Majestic, Parade, and Rugby, are much less susceptible.

CONDITIONS FAVORING DISEASE

The disease is favored by daytime temperatures of 85° to 95° F and night temperatures of 70° F or above.

MANAGEMENT

Fusarium blight occurs most commonly in areas that have been stressed for moisture and in areas in full sun. Follow proper irrigation and fertilization practices and regularly dethatch the turfgrass. Fungicides may be required if the turfgrass has a history of fusarium blight, but complete control is difficult to achieve with fungicides.

Cultural Control

Follow recommended irrigation scheduling practices based on evapotranspiration need of the turfgrass to avoid moisture stress. Because the disease is also worse under excessive nitrogen, recommended fertilization practices should also be implemented. Use 20% perennial ryegrass when seeding bluegrass, and choose resistant varieties. Low cutting heights on golf courses may worsen infestation, as well as excessive thatch.

Treatment Decisions

The crown and basal rot associated with fusarium blight is difficult to control with fungicides. If using fungicides with little or no systemic activity (iprodione), apply them preventively when environmental conditions favor the development of the disease. Systemic fungicides can be used either at this same time, or soon after symptoms begin to appear.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. IPRODIONE			
(Chipco 26019)	8 fl oz/1000 sq ft.	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
B. MYCLOBUTANIL			
(Eagle 20EW)	1.2–2.4 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
C. PROPICONAZOLE			
(Banner Maxx)	2–4 fl oz/1000 sq ft	12	Until dry

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
D. THIOPHANATE-METHYL			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
E. TRIADIMEFON			
(Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
COMMENTS: Provides the most effective control.			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

LEAF BLOTCH (12/16)

Pathogen: *Bipolaris cynodontis*

DESCRIPTION OF THE DISEASE

Leaf blotch appears as tiny purplish to reddish spots that occur on leaf blades and leaf sheaths. Seedlings are very susceptible, but older plants rapidly become resistant. Affected seedlings wither, die, and turn brown. The roots and crowns of infected plants may develop small lesions and rot. The disease occurs in irregular patches that range in size from 2 inches to 3 feet across.

SUSCEPTIBLE TURFGRASSES

Leaf blotch is a disease of bermudagrass. The pathogen survives in infected bermudagrass plants and debris.

CONDITIONS FAVORING DISEASE

Leaf blotch damages young bermudagrass seedlings or adult plants that are weakened by factors such as excess thatch, nitrogen deficiency, and other unfavorable growing conditions. The disease attacks during cool, wet weather, with symptoms usually seen from late autumn to spring.

MANAGEMENT

Follow good management practices; fungicides are usually not necessary except in young turfgrass.

Cultural Control

Remove thatch at regular intervals and apply adequate nitrogen to help prevent the development of this disease. Manage leaf wetness by irrigating pre-dawn to early morning.

Treatment Decisions

Fungicides are primarily used in young turfgrass; established, healthy turfgrass is not usually damaged by this disease.

	Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN (Heritage) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)	0.2–0.4 oz/1000 sq ft	4	Until dry
B.	CAPTAN (Captan 4L or 50 WP) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)	Label rates.	See label	Until dry
C.	CHLOROTHALONIL (Daconil Action) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)	Label rates	12	Until dry
D.	FLUDIOXONIL (Medallion) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)	0.25–0.5 oz/1000 sq ft	12	Until dry
E.	IPRODIONE (Chipco 26019) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)	3–4 fl oz/1000 sq ft.	See label	Until dry
F.	MANCOZEB (Fore 80WP) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3) COMMENTS: Dithane M-45 registered for use on sod farms only.	4–8 oz/1000 sq ft	24	Until dry

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
G. MYCLOBUTANIL (Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H. PROPICONAZOLE (Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
I. THIOPHANATE-METHYL (Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
J. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
K. VINCLOZOLIN (Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

LEAF SPOT (12/16)

Pathogen: *Bipolaris sorokiniana*

DESCRIPTION OF THE DISEASE

Leaf spot occurs on leaf blades, sheaths, and stems as circular to elongated purplish or brown spots with brown colored centers and purplish to dark brown borders. Spots may be found on turfgrass leaves throughout the site, indicating spread by windborne spores. Crown and roots are frequently affected with a dark brown rot. Plants with crown infections are weakened and may die in hot, windy weather, resulting in a thinning out of the turf in scattered areas.

SUSCEPTIBLE TURFGRASSES

Bentgrasses, bluegrasses, fescues, and ryegrasses are susceptible to leaf spot. The fungus survives in infected grass plants or grass debris and may be seedborne. Spores are airborne.

CONDITIONS FAVORING DISEASE

The disease is favored by warm temperatures (70° to 90° F), high humidity, extended leaf wetness, and closely cropped turfgrass. It is more severe under high nitrogen fertilization.

MANAGEMENT

Follow good management practices to prevent the development of leaf spot. Fungicides are usually not warranted.

Cultural Control

Reduce shade and improve soil aeration and water drainage. Avoid dry spots, overfertilizing with nitrogen, and maintain as high a cutting height as possible. Avoid prolonged leaf wetness by irrigating in pre-dawn, or early morning hours. If possible, increase air movement.

Treatment Decisions

Leaf spot usually is not serious enough in California to warrant the use of fungicides although they may be used in areas where leaf spot is severe.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. CAPTAN (Captan 4L or 50 WP)	Label rates	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
C. CHLOROTHALONIL (Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
D. FLUDIOXONIL (Medallion)	0.25–0.5 oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)			
E. IPRODIONE (Chipco 26019)	3–4 fl oz/1000 sq ft.	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
F. MANCOZEB (Fore 80 WP, Dithane M-45)	4–8 oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Dithane M-45 registered for use on sod farms only.			
G. MYCLOBUTANIL (Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H. PROPICONAZOLE (Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
I. THIOPHANATE-METHYL (Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
J. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
K. VINCLOZOLIN (Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

MELTING OUT (12/16)

Pathogen: *Drechslera poae*

DESCRIPTION OF THE DISEASE

Melting out causes circular to elongated purplish or brown spots with straw-colored centers on leaf blades, leaf sheaths, and stems. The leaf spots may be widespread throughout the lawn, indicating spread by windborne spores. Crowns and roots are frequently affected with a dark brown rot. The crown-infected plants are weakened and may die in hot, windy weather, resulting in a thinning out of the turf in scattered areas. The fungus survives on infected bluegrass plants or grass debris and may be seedborne.

SUSCEPTIBLE TURFGRASSES

Kentucky bluegrass is highly susceptible to melting out. Many improved bluegrass selections are resistant, including: Adelphi, Bristol, Destiny, Eclipse, Enmundi, Glade, Ikone, Liberty, Majestic, Mona, P-104, Rugby, and Somerset.

CONDITIONS FAVORING DISEASE

Cool (50° to 75° F), moist conditions favor melting out. Symptoms first appear on shaded plants. Melting out is most severe on closely mowed turf and on turf with high nitrogen fertilization.

MANAGEMENT

To prevent the development of melting out, follow good management practices. Reduce shade, improve soil aeration and water drainage, and control thatch. Avoid dry spots and maintain as high a cutting height as feasible. Apply recommended rates of nitrogen fertilizers. Select resistant cultivars. With the use of resistant cultivars and other recommended cultural management practices, fungicides should not be necessary in most situations. For susceptible cultivars, treat at the onset of symptoms.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN			
(Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. CAPTAN			
(Captan 4L or 50 WP)	Label rates	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
C. CHLOROTHALONIL			
(Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
D. FLUDIOXONIL			
(Medallion)	0.25–0.5 oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)			
E. IPRODIONE			
(Chipco 26019)	3–4 fl oz/1000 sq ft.	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
F. MANCOZEB			
(Fore 80 WP, Dithane M-45)	4 oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Dithane M-45 registered for use on sod farms only.			
G. MYCLOBUTANIL			

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
(Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H. PROPICONAZOLE			
(Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
I. THIOPHANATE-METHYL			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
J. TRIFLOXYSTROBIN			
(Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
K. VINCLOZOLIN			
(Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

MICRODOCHIUM PATCH
(FUSARIUM PATCH, PINK SNOW MOLD) (12/16)

Pathogen: *Microdochium nivale*

DESCRIPTION OF THE DISEASE

Microdochium patch is also called Fusarium patch as well as pink snow mold in areas that receive snowfall; the fungus can attack turf underneath the snow cover, causing considerable damage if fungicides are not applied before snowfall. This disease also occurs during periods of cool, wet weather in areas of northern California that receive no snow.

The disease appears as small, circular dead spots (up to several inches in diameter) that have a pinkish color. Often white to pink mycelia are evident in affected areas in the early morning. Small white to pink spore masses (sporodochia) can develop on infected and dead plants. The fungus survives in plants and plant debris as dormant mycelia.

SUSCEPTIBLE TURFGRASSES

Annual bluegrass and creeping bentgrass are very susceptible to this disease.

CONDITIONS FAVORING DISEASE

The pathogen can be active across a broad range of cooler temperatures (32° to 65° F), but air temperatures above 70° F inhibits the growth of the fungus and can shut down the progression of the disease.

MANAGEMENT

Providing good soil aeration and water drainage and reducing shade can discourage the incidence of Microdochium patch. Monitor the evapotranspiration needs of turfgrass to schedule irrigations. Avoid excess nitrogen fertilization, especially in fall and maintain the soil pH between 6.5 and 6.7. High levels of potassium tend to suppress the disease. If Microdochium patch has been a problem in previous years, apply a fungicide in fall before symptoms develop.

Cultural Control

High levels of nitrogen in fall or winter months may increase susceptibility to the fungus, although a nitrogen application in spring after environmental conditions no longer favor Microdochium patch development may aid the recovery of affected areas. High potassium levels may help suppress the disease. Maintain soil pH around 6.5 to 6.7.

Treatment Decisions

In areas where Microdochium patch is chronic, apply fungicides before the advent of cool, wet weather (late fall to early spring), and continue applications until the environmental conditions no longer favor pathogen development. Resistance to dicarboximide and benzimidazole fungicides has occurred in parts of the United States but has not yet been reported in California.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN			
(Heritage)	Label rates	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. CHLOROTHALONIL			
(Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
C. FLUDIOXONIL			

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
(Medallion)	0.25–0.5 oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)			
D. IPRODIONE			
(Chipco 26019)	4–8 fl oz/1000 sq ft.	See label	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
E. MANCOZEB			
(Fore 80WP)	Label rates	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Dithane M-45 registered for use on sod farms only.			
F. MYCLOBUTANIL			
(Eagle 20EW)	1.2–2.4 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
G. PCNB			
(Turfcide 400)	Label rates	12	—
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Aromatic hydrocarbon (14)			
H. PROPICONAZOLE			
(Banner Maxx)	2–4 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
I. THIOPHANATE-METHYL			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
J. TRIFLOXYSTROBIN			
(Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
K. VINCLOZOLIN			
(Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

NECROTIC RING SPOT (12/16)

Pathogens: *Ophiospharella korrae (=Leptosphaeria korrae), O. namari (= L. namari)*

DESCRIPTION OF THE DISEASE

Necrotic ring spot appears as large, ring-shaped patches that often cause depressions in the turf. Rings may vary from a few inches to several feet in diameter. Individual plants appear to have drought stress and can be stunted or discolored red, yellow, or tan. Lower stems and roots are often covered with black runner hyphae, and in advanced stages, the affected tissue (roots, rhizomes, and crowns) may turn necrotic and black or brown. Dark fungal structures (hyphae and pseudosclerotia) may sometimes be visible on affected plant parts. The fungus survives as mycelia in plant debris and in the thatch layer. The disease can also be spread by mechanical equipment and infested sod.

SUSCEPTIBLE TURFGRASSES

Fine fescues and bentgrasses. On bermudagrass, the pathogen causes a disease known as spring dead spot.

CONDITIONS FAVORING DISEASE

Necrotic ring spot development is favored by cool, wet conditions in spring and early fall. Drought stress and high compaction can intensify symptoms later in the season.

MANAGEMENT

Follow good management practices; systemic fungicides have proven effective when applied on a preventive basis.

Cultural Control

Maintain the highest mowing height possible to help prevent the development of this disease. Follow recommended irrigation practices to avoid drought stress. Avoid excessive nitrogen fertilization. Resistant varieties of Kentucky bluegrass are available. Replant with other species such as perennial ryegrass or tall fescue.

Treatment Decisions

In areas where necrotic ring spot occurs frequently, began treatment of spring infections when soil temperatures reach 60° F and continue until environmental conditions are no longer favorable for the disease in summer. Apply fungicides in an adequate volume of water, or apply enough water after application, to allow the fungicide to penetrate into the root zone.

	Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN			
	(Heritage)	0.4 oz/1000 sq ft	4	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B.	IPRODIONE			
	(Chipco 26019)	8 fl oz/1000 sq ft.	See label	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
C.	MYCLOBUTANIL			
	(Eagle 20EW)	1.2–2.4 fl oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
D.	PROPICONAZOLE			
	(Banner Maxx)	4 fl oz/1000 sq ft	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
E.	THIOPHANATE-METHYL			

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

POWDERY MILDEW (12/16)

Pathogen: *Erysiphe graminis*

DESCRIPTION OF THE DISEASE

Powdery mildew causes grayish white, powdery growth to develop on the leaf surfaces. It begins in isolated patches before spreading over larger areas. In advanced stages of the disease, the leaf blades may turn pale yellow. The fungus survives as small, hardened fruiting bodies (cleistothecia) and may be spread into turfgrass plantings by airborne asexual spores (conidia) from other grasses and hosts.

SUSCEPTIBLE TURFGRASSES

All turfgrasses are susceptible to powdery mildew, but it is most severe on Kentucky bluegrass and fescues.

CONDITIONS FAVORING DISEASE

Powdery mildew is most injurious in shady areas with high humidity and poor air circulation with temperatures at about 65° F.

MANAGEMENT

In areas that are prone to powdery mildew, plant less susceptible species. The incidence of powdery mildew can be reduced by improving air circulation and reducing shade. Be sure that moisture and fertility are adequate, and raise the mowing height where feasible. Fungicides are generally required only in severe cases.

	Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN (Heritage) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)	0.2–0.4 oz/1000 sq ft	4	Until dry
B.	MYCLOBUTANIL (Eagle 20EW) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)	1.2 fl oz/1000 sq ft	24	Until dry
C.	PROPICONAZOLE (Banner Maxx) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)	1–2 fl oz/1000 sq ft	12	Until dry
D.	THIOPHANATE-METHYL (Fungo Flo) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)	Label rates	12	Until dry
E.	TRIADIMEFON (Bayleton 50 Turf and Ornamental) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)	Label rates	12	Until dry
F.	TRIFLOXYSTROBIN (Compass) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)	Label rates	12	Until dry

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

PYTHIUM BLIGHT (GREASE SPOT) (12/16)

Pathogen: *Pythium* spp.

DESCRIPTION OF THE DISEASE

Pythium blight, also known as grease spot, kills turf in small, roughly circular spots (2 to 6 inches) that tend to run together. Blackened leaf blades rapidly wither and turn reddish brown. Leaf blades tend to lie flat, stick together, and appear greasy. Roots may be brown and rotten.

When dew or high humidity is present, especially in the early morning, white, cottony mycelia can be seen in diseased areas. These areas may have an orange to purplish border or smoke ring. Diseased areas may "run" with the pattern of water drainage, or mowing. The symptoms may appear rapidly under favorable conditions, sometimes killing large areas of grass within 24 hours. This is the foliar form of Pythium; the pathogen may also cause seedling damping off or root rots.

SUSCEPTIBLE TURFGRASSES

All grasses are susceptible to Pythium blight, which can be caused by several different *Pythium* species. Certain *Pythium* species attack some grasses more preferentially, although the distribution of these species in California is not known at this time.

CONDITIONS FAVORING DISEASE

Infection and disease development is associated with daytime air temperatures above 86° F, night temperatures above 68° F and 15 or more hours of relative humidity above 90%. Lush grass with high nitrogen nutrition appear to be more susceptible to the disease as are young/germinating seedlings, so care must be taken during overseeding or establishment in hot weather. The fungus forms thick-walled sexual spores that enable it to survive in soil and plant debris for long periods.

MANAGEMENT

Proper irrigation is the most important factor in the management of this disease, especially during periods of high nighttime temperatures.

Cultural Control

Avoid overwatering; irrigate only when needed to a depth of 4 to 6 inches. Avoid mowing wet grass or applying high levels of nitrogen during hot, humid weather. Reduce shading and improve soil aeration and water drainage. Time establishment of new turf from seed or overseeding for periods when environmental conditions are not favorable for the development of this disease.

Treatment Decisions

Due to the speed at which this disease can destroy grass, use fungicides preventively when environmental conditions favor Pythium development, or soon after symptoms are first evident. Apply a fungicide during overseeding or establishment if temperatures are high and the established area is being heavily irrigated. Fungicide treated seed is available.

Resistance has developed to mefenoxam for *Pythium* in a number of locations in the United States. Practice resistance management by alternating the use of fungicides from different chemical classes. In cases where mefenoxam no longer provides control, switch to a fungicide of a different chemistry.

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
B. FOSETYL-AL			
(Aliette WDG, Prodigy, Chipco Signature)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phosphonate (33)			
C. MANCOZEB			
(Fore 80WP, Dithane M-45)	8 oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: For pythium blight control but not pythium root rot. Dithane M-45 registered for use on sod farms only.			
D. MEFENOXAM			
(Apron XL)	Label rates	48	—
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylamide (4)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

PYTHIUM ROOT ROT (12/16)

Pathogen: *Pythium* spp.

DESCRIPTION OF THE DISEASE

Pythium root rot causes poor growth as a result of rotten roots. Small, bleached patches develop in the turf that may progress to large dead areas. Affected roots of plants can appear necrotic, or seemingly normal, although incubation under laboratory conditions at high humidity will cause the fungus to emerge from the tissue. Foliage can appear cholorotic or necrotic, wet and greasy. The fungus survives as thick walled resting structures (oospores) in old roots and in the soil and thatch.

SUSCEPTIBLE TURFGRASSES

Creeping bentgrass and annual bluegrass grown on golf greens are particularly susceptible to Pythium root rot, but the disease can affect all other turfgrasses as well.

CONDITIONS FAVORING DISEASE

There are both cool-season and warm-season *Pythium* species that cause root rot. Both groups can cause disease when turf is overirrigated and soil drainage is poor. Cool-season Pythium root rots usually occur at air temperatures of 55° to 70° F and generally are slow moving, causing small thinned areas of turf. Warm weather Pythiums are most active at air temperatures above 86° F and can cause explosive, rapid disease overnight under favorable conditions.

MANAGEMENT

Irrigation management is key to managing this disease, but fungicide applications can be made as needed.

Cultural Control

If pythium root rot is a problem in turfgrass, improve drainage and do not overwater. Increase mowing height as feasible to reduce plant stress. Manage the thatch layer to allow for proper water penetration into the soil. Irrigate as needed occurring to evapotranspiration rates.

Treatment Decisions

For warm-season Pythium diseases, time fungicide applications preventively or at the very first onset of disease symptoms. Make fungicide applications for cool-season Pythiums when symptoms develop.

Resistance has developed to mefenoxam for *Pythium* in a number of locations in the United States. Practice resistance management by alternating the use of fungicides from different chemical classes. In cases where mefenoxam no longer provides control, switch to a fungicide in a different chemical class.

Common name (Example trade name)	Example trade names	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. FOSETYL-AL			
(Aliette WDG , Prodigy, Chipco Signature)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phosphonate (33)			
B. MEFENOXAM			
(Apron XL)	Label rates	48	—
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylamide (4)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

RED THREAD (12/16)

Pathogen: *Laetisaria fuciformis*

DESCRIPTION OF THE DISEASE

Red thread may kill turfgrass in patches that are 2 to 8 inches in diameter, or the disease may occur over large areas without killing the plants. A pink web of fungal threads binds the leaves together. Look for pink, gelatinous fungal crusts projecting from the leaves to help identify this disease.

SUSCEPTIBLE TURFGRASSES

Bentgrasses, bluegrasses, fescues, ryegrasses, and bermudagrasses are susceptible to red thread.

CONDITIONS FAVORING DISEASE

This disease occurs most frequently along the coast of northern and central California but may be found in southern California on rare occasions. The disease is common under conditions of mild air temperatures (60° to 75° F) and extended periods of leaf wetness. It often appears on plants deficient in nitrogen during periods of cool or warm temperatures if there is adequate moisture (excess irrigation or rainfall).

MANAGEMENT

Providing proper irrigation and fertilization can reduce the incidence of red thread. Adequate nitrogen can usually prevent this disease from occurring. Prevent drought stress by irrigating turfgrass based on evapotranspiration needs of the turfgrass. Provide adequate air circulation and reduce shading. Fungicides are rarely warranted except in severe cases.

	Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN			
	(Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B.	CHLOROTHALONIL			
	(Daconil Action)	Label rates	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
C.	FLUTOLANIL			
	(Prostar WG)	Label rates	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)			
D.	IPRODIONE			
	(Chipco 26019)	4 fl oz/1000 sq ft.	See label	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			
E.	MANCOZEB			
	(Fore 80WP, Dithane M-45)	4–8 oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
	COMMENTS: Dithane M-45 registered for use on sod farms only.			
F.	MYCLOBUTANIL			
	(Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
G.	PROPICONAZOLE			
	(Banner Maxx)	2 fl oz/1000 sq ft	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H.	THIOPHANATE-METHYL			

Common name (Example trade name)	Amount to use	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
UPDATED 12/16			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
I. TRIADIMEFON			
(Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
J. TRIFLOXYSTROBIN			
(Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
K. VINCLOZOLIN			
(Curalan EG, Touche EG)	2.7 lb/acre (1 oz/1000 sq ft)	120 (5 days)	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

RHIZOCTONIA BLIGHT
(BROWN PATCH, LARGE PATCH, YELLOW PATCH) (12/16)

Pathogens: *Rhizoctonia solani* and *R. cerealis*

DESCRIPTION OF THE DISEASE

There are three types of Rhizoctonia blight: large patch, a blight of warm-season grasses that is caused by *Rhizoctonia solani*; brown patch, a blight of cool-season grasses that is also caused by *R. solani*; and yellow patch, a blight of annual and Kentucky bluegrass caused by *R. cerealis*. When weather conditions are not favorable for disease development, both species can survive as sclerotia in the thatch and soil or as mycelia in plants and debris.

Large patch on warm-season grasses appears as light green patches in fall. Infected areas may become bright yellow and then turn brown as the grass emerges from dormancy in spring. Spring symptoms can persist in cool, wet weather for an extended duration; bermudagrass can recover quickly as the weather warms, while other grasses, such as zoysiagrass, take many weeks to recover. There is often a soft, dark brown to purplish rot of the lower portion of the leaf sheaths that can develop into a reddish brown necrosis of the leaf sheath and stem under dry conditions. In severe cases, plants will be affected by an extensive soft rot of the stems.

Brown patch affects cool-season grasses during periods of hot weather. On closely mowed turf, patches of blighted turf will often have a purplish edge or smoke ring appearance in the early morning hours. Initial patches may first appear purplish-green and turn brown as the disease progresses. On taller turf plantings, patches will appear as blighted turf that turns dull tan to brown. The fungus causes dull tan lesions on leaves that may develop a reddish brown margin. Plants killed by the fungus will often have a light brown color, and turn brittle, but will not have a wet, greasy appearance.

Yellow patch occurs primarily on annual bluegrass and Kentucky bluegrass in cool, moist weather. Symptoms include the development of yellow or tan-colored patches of turf. On leaves, there is a yellow to tan chlorosis that extends down from the leaf tips. Gray-tan lesions may develop on lower leaf portions and often on Kentucky bluegrass, some leaves may become reddish or reddish purple. In periods of extended cool, wet weather, affected leaves may become necrotic, but in many cases the main symptom is only a yellow chlorosis.

SUSCEPTIBLE TURFGRASSES

Large patch: Bermudagrass, zoysiagrass, St. Augustinegrass, kikuyugrass
Brown patch: bentgrasses, fescues, ryegrasses, bluegrasses
Yellow patch: annual bluegrass, Kentucky bluegrass, bermudagrass, perennial ryegrass, zoysiagrass, bentgrasses

CONDITIONS FAVORING DISEASE

Generally, Rhizoctonia diseases are more severe under conditions of poor drainage, high compaction, thick thatch layers, long periods of leaf wetness, low mowing heights, excessive mechanical damage, and high nitrogen fertilization.

Large patch develops in fall and spring when warm-season grasses are going into or coming out of dormancy.

Brown patch is common when temperatures are in the range of 75° to 95° F, with the optimal conditions for leaf colonization being temperatures of 85° to 90° F with high humidity or extended leaf wetness periods.

Yellow patch usually develops when air temperatures are from 50° to 65° F and there is high humidity or extended periods of leaf wetness. In many cases, the turf will recover when temperatures go above or below this range.

MANAGEMENT

Irrigation and leaf wetness management is an important part of controlling Rhizoctonia diseases. Fungicide applications can be necessary if leaf wetness and soil moisture cannot be adequately managed (for instance, as a result of rain or high humidity). Combine cultural management techniques with fungicide applications for the best management of the disease.

Cultural Control

Cultural practices that improve water and fertility management are useful in preventing the development of rhizoctonia blight. Reduce shading and improve soil aeration and water drainage. Irrigate in the pre-dawn or early morning hours to promote leaf drying. Irrigate only when needed to a depth of 4 to 6 inches. Remove dew from leaves by poling or light irrigation. Avoid nitrogen fertilization that results in a soft foliage growth. Maintain thatch at less than 0.5 inch.

Treatment Decisions

For areas where large patch and yellow patch are chronic, fall fungicide applications may be necessary; otherwise, make fungicide applications soon after the first symptoms of disease are seen. Some fungicides that are active against *R. solani* may not be specifically labeled for *R. cerealis*.

	Common name (Example trade name)	Amount to use	Ag Use REI ‡ (hours)	NonAg Use REI ‡ (hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN (Heritage) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)	0.2–0.4 oz/1000 sq ft	4	Until dry
B.	CHLOROTHALONIL (Daconil Action) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)	Label rates	12	Until dry
C.	FLUDIOXONIL (Medallion) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)	Label rates	12	Until dry
D.	FLUTOLANIL (Prostar WG) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)	Label rates	12	Until dry
E.	IPRODIONE (Chipco 26019) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Dicarboximide (2)	3–4 fl oz/1000 sq ft.	See label	Until dry
F.	MANCOZEB (Fore 80WP, Dithane M-45) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3) COMMENTS: Dithane M-45 registered for use on sod farms only.	4 oz/1000 sq ft	24	Until dry
G.	MYCLOBUTANIL (Eagle 20EW) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3) COMMENTS: Do not apply more than 7.2 oz/1000 sq ft/year.	1.2 fl oz/1000 sq ft	24	Until dry
H.	PCNB (Turfcide 400) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Aromatic hydrocarbon (14)	Label rates	12	—
I.	PROPICONAZOLE (Banner Maxx) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)	1–2 fl oz/1000 sq ft	12	Until dry
J.	THIOPHANATE-METHYL (Fungo Flo) MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)	Label rates	12	Until dry
K.	TRIADIMEFON (Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry

Common name (Example trade name)	Amount to use	Ag Use REI ‡ (hours)	NonAg Use REI ‡ (hours)
UPDATED 12/16			
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
L. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

RUST (12/16)

Pathogens: *Puccinia striiformis*, *P. graminis*, *P. coronata*, and *Uromyces spp*.

DESCRIPTION OF THE DISEASE

Rust begins as small yellow spots on leaves and stems that form elongated, reddish brown or orange pustules. Shoes and clothes are often stained orange by the spores when walking through infested areas. Rust kills leaves and debilitates plants when it is severe. The turfgrass quality is reduced because of poor color and reduced plant vigor. Rust survives as dormant mycelia in infected plants and as teliospores; it may spread to turf from infections on other grasses and woody ornamentals.

SUSCEPTIBLE TURFGRASSES

Bluegrasses, ryegrasses, zoysiagrass, and tall fescue.

CONDITIONS FAVORING DISEASE

Moderately warm, moist weather favors rust development. Moisture in the form of dew for 10 to 12 hours is sufficient for the spores to infect plants. Warm air temperatures (70° to 75° F) and extended periods of leaf wetness favor the development of the disease. The disease is more severe in turf deficient in nitrogen.

MANAGEMENT

Rust can usually be managed with proper mowing, fertilizing, and irrigation practices.

Cultural Control

To reduce the incidence of rust, maintain turfgrass vigor by applying adequate but not excessive nitrogen fertilization and irrigate in the morning according to the evapotranspiration needs of the turfgrass. Provide good air movement on surface of grass. Mow the turfgrass regularly and remove clippings if the lawn is infected to reduce the number of spores. Mixtures of several compatible turfgrass species fare better against rust than turfgrass composed of a single species. Most Kentucky bluegrass and tall fescue varieties currently marketed in California are fairly resistant to rust.

Treatment Decisions

Rust can usually be managed successfully through cultural practices, but in severe cases fungicide applications can be made.

Common name (Example trade name)	Amount to use	Ag Use REI ‡ (hours)	NonAg Use REI ‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. CHLOROTHALONIL (Daconil Action)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
C. MANCOZEB (Fore 80WP, Dithane M-45)	4 oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
COMMENTS: Dithane M-45 registered for use on sod farms only.			
D. MYCLOBUTANIL (Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
E. PROPICONAZOLE (Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry

Common name (Example trade name)	Amount to use	Ag Use REI ‡ (hours)	NonAg Use REI ‡ (hours)
UPDATED 12/16			
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
F. THIOPHANATE-METHYL (Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
G. TRIADIMEFON (Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
H. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotatingz to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

SCLEROTIUM BLIGHT (SOUTHERN BLIGHT) (12/16)

Pathogen: *Sclerotium rolfsii*

DESCRIPTION OF THE DISEASE

Sclerotium blight affects circular areas of turf, enlarging up to 9 feet in diameter; some plants may remain alive in the centers of these areas. Sometimes only partial circles or crescent-shaped areas of affected turf are seen. The turfgrass turns reddish brown as it dies. Infected plants appear completely necrotic. As the fungus advances, abundant white mycelia appear on the turfgrass. Light to dark brown sclerotia, which are tiny, hard, resting bodies that resemble mustard seeds, develop at the base of the stems and may help identify this disease.

SUSCEPTIBLE TURFGRASSES

Bentgrasses, bluegrass, fescues, ryegrasses, dichondra are susceptible to southern blight.

CONDITIONS FAVORING DISEASE

The fungus survives in thatch as sclerotia. Spread is by sclerotia and infected plant parts. The disease is favored by warm or hot weather, high moisture, and heavy thatch. Initial infections commonly occur in late spring, when air temperatures rise above 75° F; several days of drought followed by high soil moisture appears to be conducive to high levels of sclerotia germination. Optimal conditions for disease development are air temperatures of 85° to 95° F coupled with high moisture in the thatch layer from precipitation, high humidity, or over irrigation.

MANAGEMENT

Prevent the development of Sclerotium blight by following good cultural practices. Fungicides may be necessary in areas where this disease is chronic.

Cultural Control

The disease appears to be less destructive on well fertilized, vigorously growing grass. Control thatch and use good sanitation practices around equipment, because both aerifying and verticutting can spread the fungus sclerotia. Avoid overirrigation.

Treatment Decisions

In areas where southern blight is chronic, fungicide applications can be made in late spring before the development of symptoms; otherwise, apply fungicides soon after symptoms are seen.

Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. FLUTOLANIL (Prostar WG)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Carboxamide (7)			
C. TRIADIMEFON (Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

SEED ROT and DAMPING-OFF (12/16)

Pathogens: *Pythium* spp., *Rhizoctonia* spp., *Fusarium* spp.

DESCRIPTION OF THE DISEASE

Seeds affected by seed rot are rather dry and do not germinate. Damping off may affect seedlings at either the pre- or postemergence stage. The hypocotyl area of seedlings is particularly susceptible. Seedlings appear water soaked, then blacken, shrivel, and turn brown with stunted growth.

SUSCEPTIBLE TURFGRASSES

All grasses are susceptible to these diseases.

CONDITIONS FAVORING DISEASE

Seed rot and damping off can occur at a wide range of temperatures (50° to 100° F) but are more common at temperatures above 70° F. Seed rot and damping off are favored by excessive moisture and by sowing seeds of low viability above the recommended rates, especially during periods unfavorable for seed germination and growth.

MANAGEMENT

Before planting a site with turfgrass, make sure the soil is adequately aerated and there is good drainage. Sow fresh, healthy seed at recommended rates and seasons. Do not seed cool-season turfgrass during hot weather. As the turfgrass grows, avoid overwatering. Seeds should be treated with fungicide before they are planted and again at first evidence of symptoms of damping off.

Treatment Decisions

Mancozeb, captan, thiram and mefenoxam are common fungicide seed treatments. Resistance has developed to mefenoxam for *Pythium* in a number of locations in the United States. Practice resistance management by alternating the use of fungicides with a different chemistry. In cases where mefenoxam no longer provides control, switch to a fungicide in a different chemical class.

	Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	CAPTAN			
	(Captan 4L or 50 WP)	Label rates	See label	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
B.	FLUDIOXINIL			
	(Medallion)	Label rates	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)			
	COMMENTS: Effective against *Rhizoctonia* and *Fusarium.*			
C.	MANCOZEB			
	(Fore 80WP, Dithane M-45)	Label rates	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
	COMMENTS: Effective against *Pythium.* Dithane M-45 registered for use on sod farms only.			
D.	MEFENOXAM			
	(Apron XL)	Label Rates	48	—
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylamide (4)			
	COMMENTS: Effective against *Pythium*; not effective against *Rhizoctonia* and *Fusarium*.			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

SPRING DEAD SPOT (12/16)

Pathogens: *Ophiosphaerella korrae (=Leptosphaeria korrae)* and *O. narmari (=L. narmari)*

DESCRIPTION OF THE DISEASE

Spring dead spot appears as circular areas of dead grass, 6 to 12 inches in diameter when turf resumes growth in spring. The spots may coalesce to form large areas. On affected plants dark elliptical sclerotia are often visible on stolons. Dark sunken lesions can be seen on affected crown buds, roots and stolons; these areas may become black, necrotic, and brittle in advanced stages of infection. Sometimes, the symptoms are not evident until 2 or more years after the establishment of the disease. Overseeding bermudagrass with another turf species may mask the symptoms of this disease.

SUSCEPTIBLE TURFGRASSES

Bermudagrass is susceptible to spring dead spot.

CONDITIONS FAVORING DISEASE

The pathogen survives in debris (old thatch and roots) as fungal threads and sclerotia, which are tiny, hard, often dark, resting bodies. Spring dead spot is spread by sclerotia and infected plant parts, as well as through infested sod. Initial infections of new tissue begin in late summer or fall when air temperatures range between 70° to 75° F. When the bermudagrass goes into dormancy (daily air temperatures of 50° to 60° F or lower), the fungus continues to colonize and kill the affected tissue. Damage to the affected plants is usually only visible when the bermudagrass emerges from dormancy.

MANAGEMENT

The focus of a spring dead spot management program should be exclusion of the pathogen from new plantings and promoting strong, healthy turf and root systems that can tolerate and recover quickly from the damage caused by the fungus. Proper irrigation and fertilization are important in the management of this disease. Spring dead spot is difficult to manage with fungicides.

Cultural Control

Establish new turf plantings with clean sod from areas where spring dead spot has not been a problem. Irrigate according to evapotranspiration needs of the turfgrass. Dead grass can be raked out and replanted with new bermudagrass seed or stolons; alternately, bermudagrass can be overseeded with ryegrass in fall or winter to hide disease symptoms in spring.

Thick thatch and low mowing heights favor the development of the disease. Manage thatch and keep it less than 0.5 inches thick with regular dethatching and aerification. Provide adequate irrigation based on evapotranspiration needs to promote vigorous growth during summer months and reduce drought stress damage. Raise mowing height in late summer or early fall to reduce pre-dormancy stress.

Maintain adequate levels of potassium in the soil and apply potassium fertilizers in fall to promote winter hardiness. Use adequate nitrogen fertilization programs in spring and summer, but minimize nitrogen applications in late summer and fall. Late summer and fall applications may contribute to disease severity because the added nitrogen promotes the growth of leaves at the expense of roots and may delay the bermudagrass from entering dormancy, resulting in both a reduction in cold hardiness and carbohydrate reserves. Loss of carbohydrate reserves is detrimental to plants when they are emerging from dormancy in spring. Use ammonium-based nitrogen sources versus nitrate- or urea-based fertilizers. Maintaining a low soil pH (5.2 to 5.3) appears to reduce the severity of the disease.

Treatment Decisions

Once established, spring dead spot is a difficult disease to control with fungicides. Best results are usually seen when a combination of cultural and chemical control methods is used. Make one or two fungicide applications beginning in the late summer or early fall using enough water volume to get the fungicide into the root zone.

Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. MYCLOBUTANIL (Eagle 20EW)	2.4 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
C. PROPICONAZOLE (Banner Maxx)	4 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

STRIPE SMUT (12/16)

Pathogen: *Ustilago striiformis*

DESCRIPTION OF THE DISEASE

Plants infected with stripe smut are often pale green and stunted with long, black stripes of spore pustules. Infected leaves curl, then die and become shredded. Fungal spores formed in the leaves can contaminate seed and infect seedlings and young tillers. The fungus survives in the grass plant.

SUSCEPTIBLE TURFGRASSES

Bentgrasses, perennial ryegrass, fescues, and bluegrasses are susceptible to stripe smut.

CONDITIONS FAVORING DISEASE

Stripe smut is favored by moderate temperatures and is prevalent in spring and fall. Temperatures between 60° to 78° F are conducive to infection and symptom expression. Infected plants may die in hot, dry weather.

MANAGEMENT

Cultural Control

Infected turf is generally under higher drought stress, so irrigate adequately based upon evapotranspiration needs, but avoid extended periods of prolonged leaf wetness. Avoid excessive nitrogen fertility during the summer months.

Treatment Decisions

Apply fungicides only if the disease is severe. Seed treated with a broad-spectrum fungicide like captan can possibly prevent initial infections of seedlings.

	Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN			
	(Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B.	CAPTAN			
	(Captan 4L or 50 WP)	Label rates	See label	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M4)			
	COMMENTS: Seed treatment for susceptible cultivars.			
C.	CHLOROTHALONIL			
	(Daconil Action)	Label rates	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M5)			
D.	MANCOZEB			
	(Fore 80WP, Dithane M-45)	4 oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Multi-site contact (M3)			
	COMMENTS: Dithane M-45 registered for use on sod farms only.			
E.	MYCLOBUTANIL			
	(Eagle 20EW)	1.2 fl oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
F.	PROPICONAZOLE			
	(Banner Maxx)	1–2 fl oz/1000 sq ft	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			

Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
UPDATED 12/16			
G. THIOPHANATE-METHYL			
(Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
H. TRIADIMEFON			
(Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
I. TRIFLOXYSTROBIN			
(Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

SUMMER PATCH (12/16)

Pathogen: *Magnaporthe poae*

DESCRIPTION OF THE DISEASE

Summer patch appears as circular yellow or tan areas up to 1 foot in diameter, consisting of dead and dying plants. Roots, crowns, and stolons are affected by a dark brown rot. Young roots may appear healthy, although dark brown hyphae may be present on these tissues. Vascular discoloration and cortical rot occur in later stages of the disease. On occasion, patches may retain centers of green, apparently unaffected grass. The fungus can survive as mycelia in plant debris or in host tissue.

SUSCEPTIBLE TURFGRASSES

This disease has been reported on red fescue, Chewing's fescue, hard fescue, perennial ryegrass, and creeping bentgrass, but appears to be most destructive to annual bluegrass and Kentucky bluegrass.

CONDITIONS FAVORING DISEASE

Infections occur when soil temperatures are consistently at 65° to 70° F, and symptoms tend to appear when air temperatures are 83° to 95° F or higher. The disease is most severe on closely mowed turf (e.g. golf greens) with heavy irrigation or high soil moisture.

MANAGEMENT

Follow good cultural practices to prevent the development of summer patch. Fungicides may be required for control if summer patch has been a problem in previous years.

Cultural Control

Promote root growth by soil aeration and slow-release nitrogen. Improve drainage, reduce compaction and mechanical damage or traffic, control thatch, and avoid drought stress. Irrigate based on evapotranspiration needs of turfgrass. Do not set mowing height lower than necessary. Lightly water (syringe) turf during periods of hot weather to reduce heat stress.

Treatment Decisions

In areas where summer patch is frequent, begin fungicide applications when soil temperatures begin to be consistently in the 65° to 70° F range. This may be 3 to 4 weeks before symptoms are typically seen. Apply fungicides in a water volume equivalent to about 2 to 4 gal/1000 sq. ft. of water in fungicides to ensure materials reach the root zone. Fungicide applications made after strong symptom expression are generally ineffective.

Repeated applications of fungicides from the same chemical class for summer patch control may contribute to the development of fungicide resistance in anthracnose for the benzimidazole, DMI, and QoI (strobilurins) fungicides because the diseases tend to occur during the same period.

	Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
	UPDATED 12/16			
	When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A.	AZOXYSTROBIN (Heritage)	0.2–0.4 oz/1000 sq ft	4	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B.	FLUDIOXONIL (Medallion)	0.5 oz/1000 sq ft	12	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Phenylpyrrole (12)			
C.	MYCLOBUTANIL (Eagle 20EW)	1.2–2.4 fl oz/1000 sq ft	24	Until dry
	MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			

Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
UPDATED 12/16			
D. PROPICONAZOLE (Banner Maxx)	Label Rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
E. THIOPHANATE-METHYL (Fungo Flo)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Methyl benzimidazole (1)			
F. TRIADIMEFON (Bayleton 50 Turf and Ornamental)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
G. TRIFLOXYSTROBIN (Compass)	Label rates	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

TAKE-ALL PATCH (12/16)

Pathogen: *Gaeumannomyces graminis* var. *avenae*

DESCRIPTION OF THE DISEASE

Take-all patch appears as circular or ring-shaped dead areas that range from a few inches up to 3 feet or more in diameter. Dying bentgrass at the advancing margins of these areas has a purplish tinge. The roots of the diseased plants are rotted and have dark strands of mycelium visible on the surface of the roots. Large black perithecia, which are globular or flask-shaped fungal fruiting bodies, may be visible with the use of a hand lens. The pathogen survives in grass debris and living grass plants.

SUSCEPTIBLE TURFGRASSES

Bentgrasses are the most susceptible, but bluegrass, fescues, and ryegrasses are also susceptible to take-all patch.

CONDITIONS FAVORING DISEASE

In California, take-all patch principally occurs in late fall and winter when air temperatures are 50° to 60° F and soils are wet or moist, but symptoms may not manifest until the turf is exposed to periods of drought or heat stress. Soil conditions that favor the disease include light texture, low organic matter, low or unbalanced fertility, high pH, and high moisture. The disease may be spread by spores produced by the perithecia, in infested soil and sod, or by dethatching and aerification equipment.

MANAGEMENT

To prevent the development of this disease, make sure the turfgrass has adequate soil drainage and fertility.

Cultural Control

Recovery of bentgrass can be slow on closely mowed turf; affected areas can be resodded if necessary, and some varieties with improved tolerance are available. Raising manganese levels in the soil (or lowering pH) appears to suppress the disease. If the soil pH is above 7, lower it using elemental sulfur. Fertilize in fall with ammonium sulfate. Also, irrigate based on evapotranspiration needs of turfgrasses.

Treatment Decisions

Fungicides may be necessary on golf greens that have experienced the disease in the past. Apply a fungicide on a preventive basis in fall.

Common name (Example trade name)	Amount to use	Ag Use REI‡(hours)	NonAg Use REI ‡ (hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
A. AZOXYSTROBIN (Heritage)	0.4 oz/1000 sq ft	4	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Quinone outside inhibitor (11)			
B. MYCLOBUTANIL (Eagle 20EW)	2.4 fl oz/1000 sq ft	24	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			
C. PROPICONAZOLE (Banner Maxx)	2–4 fl oz/1000 sq ft	12	Until dry
MODE-OF-ACTION GROUP NAME (NUMBER[1]): Demethylation inhibitor (3)			

1 Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see http://frac.info/). Fungicides with a different group number are suitable to alternate in a resistance management program. In California, make no more than one application of fungicides with mode-of-action group numbers 1, 4, 9, 11, or 17 before rotating to a fungicide with a different mode-of-action group number; for fungicides with other group numbers, make no more than two consecutive applications before rotating to fungicide with a different mode-of-action group number.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

Nematodes

(Section reviewed 12/16)

Scientific names
Lesion nematode: *Pratylenchus* sp.
Ring nematodes: *Mesocriconema* sp. (= *Criconemella, Criconemoides,* and *Macroposthonia*)
Root knot nematodes: *Meloidogyne naasi, Meloidogyne* sp.
Seed and leaf gall nematode: *Anguina pacificae*
Spiral nematodes: *Helicotylenchus* sp.
Sting nematode: *Belonolaimus longicaudatus*
Stubby root nematode: *Paratrichodorus* sp.

DESCRIPTION OF THE PESTS

Plant parasitic nematodes are microscopic roundworms that feed exclusively on plant tissues. Most species parasitize plant roots. They survive in soil and plant tissues, and several different species may coexist in turf. They have a wide host range, and vary in their environmental requirements and in the symptoms they cause. While the other species occur throughout the state, the sting nematode has only been reported from the Coachella Valley, and the seed and leaf gall nematode has only been found in Monterey and San Francisco Bay areas.

DAMAGE

Several genera of nematodes may be associated with turfgrasses in California. Statewide, root knot nematode is thought to be the most widespread and most damaging. Of the root knot species, *Meloidogyne naasi* in particular prefers grasses over other hosts and infestations of this nematode can reduce the growth and vigor of turfgrasses.

In 1992, sting nematode, a major pest of turf and other commercial crops in the southeastern United States, was collected from several turf sites in the Coachella Valley. Sting nematode feeds on the tips and along the sides of the roots. Activity of this pest is highest in sandy, moist soils when soil temperature is in the 72° to 92° F range.

Many golf courses in the Monterey and San Francisco areas with annual bluegrass (*Poa annua*) greens are infested with the seed and leaf gall nematode. Presence of this nematode is associated with localized yellowing and death of turf on greens. Root knot, spiral, and ring nematode are also commonly present on these courses.

Although not proven to be damaging to turf, lesion nematodes are commonly found associated with turfgrasses, stubby root nematode may be found feeding on growing root tips. Additional nematodes associated with turfgrasses in California are: dagger nematodes, *Xiphinema* sp.; needle nematodes, *Longidorus* sp.; pin nematodes, *Paratylenchus* sp.; and sheath nematodes, *Hemicycliophora* sp.

SYMPTOMS

The symptoms described below are indicative of a nematode problem, but are not diagnostic because they could result from other causes as well. Infestations may occur without causing any aboveground symptoms.

Aboveground symptoms of a severe nematode infestation include patches of yellow plants, stunting, and poor growth. Feeding by root knot nematodes results in swellings, called galls, on roots. Severely galled roots may appear malformed and the root system shortened and thickened.

Turf affected by sting nematode exhibits drought and malnutrition (yellowing) symptoms and does not respond to watering or feeding. Badly affected plants collapse and die in patches that can measure up to several feet in diameter.

Annual bluegrass infested with the seed and leaf gall nematode will have light-colored swellings or galls at the crown of the plant. Galls contain nematodes of different stages. Mature galls may be filled with hundreds of juvenile nematodes or with bacteria that resembles white cream.

Roots of grasses infested with lesion nematodes may exhibit brown-black lesions of various sizes and shapes. Feeding by stubby root nematodes causes swollen and/or discolored root tips and restricts root growth.

FIELD EVALUATION

To make management decisions, it is important to know the nematode species present. If nematode species have not previously been identified, take soil and plant samples and send them to a diagnostic laboratory for identification.

In established turf, randomly take several soil cores (1 to 2 inches in diameter) or a cup cutter core to a depth of 4 to 6 inches, from each area of suspected nematode infestation. To allow comparison you may take similar samples from adjacent areas with apparently healthy plants. If only soil is present, randomly take several soil cores to a depth of 6 to 8 inches to make a composite sample of about 1 quart (1 liter) for each area. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, the previous crop, and the grass you intend to grow. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory.

MANAGEMENT

Sanitation

Clean soil from equipment with water before moving from infested to noninfested areas. Avoid introducing nematode-infested soil or sod into areas free of nematodes.

Sting Nematode

Turf and soil cannot be removed from Coachella Valley golf courses where sting nematode has been documented without notifying the Riverside County Agricultural Commissioner. Soil samples should only be sent to a laboratory authorized to run quarantine samples.

Treatment Decisions

Apply a preplant treatment if sampling indicates that potentially damaging nematodes are present. When treating established turf, leave a few of the affected areas untreated for comparison if possible.

Common name (Example trade name)	Amount per acre	Ag Use REI‡(hours)	NonAg Use REI‡(hours)
UPDATED 12/16			
When choosing a pesticide, consider its usefulness in an IPM program by reviewing the pesticide's properties, efficacy, application timing, and information relating to resistance management, honey bees, and environmental impact. Not all registered pesticides are listed. Always read the label of the product being used.			
PREPLANT			
A. METAM SODIUM* (Vapam, Sectagon 42)	50–75 gal	See label	—
. . . or . . .			
METAM POTASSIUM* (K-Pam)	Label rates	See label	—
COMMENTS: Contact your farm advisor for advice on the most effective application method for a particular situation. Fumigants such as these are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			
B. 1,3-DICHLOROPROPENE* (Various products)	Label rates	See label	—
COMMENTS: Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.			

* Permit required from county agricultural commissioner for purchase or use.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

Weeds

(Section reviewed 7/09)

INTEGRATED WEED MANAGEMENT (12/16)

A dense, vigorously growing, competitive stand of turfgrass will resist invasion by weeds. Integrated weed management focuses on selecting, establishing, and maintaining a competitive stand of turfgrass. While it is difficult to eliminate all weeds from turf, in highly maintained turf it is possible to prevent large irregular patches of weeds, which make turf unattractive and reduce its utility.

The objective of an integrated weed management program is to keep weed populations below levels that are incompatible with the purpose of the turf. The first step is preparing the site properly and choosing an appropriate turfgrass species for the location, followed by cultural practices that contribute to turf vigor, such as proper irrigation, mowing, fertilization, thatch removal, and aeration. The increased vigor allows turf to better withstand insect, disease, and nematode damage and to recover more quickly. Healthy turf can also out-compete weeds and reduce the chances of their becoming established. Herbicides are used as tools in turf management where high quality turf is required; however, their use should be integrated with a good cultural program.

SELECTING A TURFGRASS

Turf species and cultivars vary in their adaptability to different areas of California. Choosing a well-adapted cultivar to plant will be one of your most important weed management decisions (see section onTURFGRASS SPECIES or refer to the UC Guide to Healthy Lawns located online at http://ipm.ucdavis.edu/TOOLS/TURF/). Cool-season species (bentgrass, bluegrass, perennial ryegrass, and tall fescue) are most competitive in the coastal and northern regions of California; some of the newer cultivars of perennial ryegrass, Kentucky bluegrass and tall fescue are more competitive and grow better than the old cultivars. Warm-season species (bermudagrass, St. Augustinegrass, zoysiagrass, seashore paspalum, and dichondra) are most competitive with weeds in the interior valleys and desert regions. When turf species are planted in areas where they are not well adapted, they require greater care (e.g. management skills and resources) to grow and maintain and are more susceptible to invasion by weeds. Irrigation, mowing, and fertilization requirements vary for each turf species and must be carefully followed to maintain their competitive edge against weed invasions.

TURF ESTABLISHMENT

(Before planting turf or when renovating weedy turf)

Before planting, annual weeds can be controlled by irrigating to germinate weed seeds in soil, followed by shallow cultivation or application of a contact herbicide. Repeat this process two or three times to improve the chances of establishing a turfgrass with a minimum of weeds. Planting turfgrass sod in well-prepared soil that has been cultivated and amended to improve water-holding capacity in sandy soil or to improve drainage in clay soils will decrease annual weeds. Poor drainage favors some weeds such as annual bluegrass, broadleaf plantain, crabgrass, curly dock, nutsedge, and red sorrel.

Populations of some perennial weeds such as dallisgrass, bermudagrass, and nutsedge can be reduced before planting turf by cultivating in summer and keeping the soil completely dry to dehydrate the propagules (stems, rhizomes, tubers). Rework the soil to bring up new propagules, but be sure to keep the soil dry; three to four cultivations a week or more apart may be needed for best results.

MANAGING ESTABLISHED TURF

Turfgrass can be established and maintained to discourage weeds in the turf or to decrease chances for weed invasion. Any condition that exposes the soil surface to additional light makes that area more susceptible to weed invasion. Factors that contribute to poor turf quality and vigor include overwatering or underwatering, mowing too low or too high, low fertility, excessive wear, disease or insect damage, soil compaction, and excessive shading.

Irrigation Management

California has a Mediterranean climate that is characterized by rainfall in winter and spring and very little rainfall in summer and fall. Irrigation is needed, therefore, for both cool- and warm-season turfgrasses. It is very important to follow good irrigation practices, regardless of turfgrass species used, so that optimum growth and development of turfgrass is obtained.

Most turfgrass sites in California are irrigated with a sprinkler irrigation system. A uniform application of water is extremely important for maximum efficiency because it is important to avoid wet and dry spots within the sward. Turf is weakened in wet spots because of poor soil aeration and root disease that can result in the invasion of shallow-rooted weeds such as crabgrass, annual bluegrass, and oxalis. Runoff from overirrigated areas is wasteful and results in accumulation of water in low parts of the sward. In contrast, dry sites will be characterized by turf of poor color, density, and uniformity that allows the invasion of deep-rooted weeds such as bermudagrass, dandelions, plantains, clover, knotweed, and yarrow.

Proper timing and an adequate amount of irrigation are necessary for optimum growth, maximum quality, and best appearance of the respective turfgrass species. Common warm-season turfgrass species in California include common and hybrid bermudagrass, St. Augustinegrass, kikuyugrass, and zoysiagrass. The most commonly planted cool-season turfgrasses for California are tall fescue, Kentucky bluegrass, and perennial ryegrass. Cool-season turfgrass species require more water than warm-season turfgrass species. Water use rates also vary based on a location's climate (low desert valleys can approach 0.37 inches per day in July, while during the same period turfgrass in northern coastal regions may require only 0.12 inches per day). The table below shows the relative water use rates of turfgrass types for three different locations in California. See local newspapers, your water district, or contact local Cooperative Extension offices for the water required in specific areas.

TABLE 1.

Water use rates (acre-inches per month) of turfgrass types at three different locations in California.

	IRVINE		DAVIS		UKIAH	
MONTH	cool-season grass	warm-season grass	cool-season grass	warm-season grass	cool-season grass	warm-season grass
January	1.2	1.2	0.8	0.6	0.8	0.6
February	1.6	1.4	1.5	1.1	1.1	0.8
March	2.8	2.8	2.6	2.0	2.0	1.5
April	4.5	3.1	4.0	3.0	2.6	2.0
May	4.6	4.0	5.1	3.8	4.1	3.0
June	4.8	3.6	6.0	4.5	4.6	3.5
July	5.9	4.3	6.5	4.9	5.4	4.0
August	5.0	4.0	5.7	4.2	4.7	3.5
September	3.6	3.1	4.3	3.3	3.6	2.7
October	2.8	1.9	3.2	2.4	2.2	1.7
November	1.8	1.5	1.4	1.1	1.0	0.8
December	1.2	0.9	0.8	0.6	0.6	0.4

Key points for maximum irrigation efficiency:

- Irrigate deeply, but infrequently.
- Irrigate early in the morning. At this time water loss from evaporation is minimal, distribution is usually good because of good water pressure and limited wind, and the risk of disease development is reduced.
- Avoid runoff by matching water application rates to soil infiltration rates (rate water enters soil) or by pulsing (i.e., applying a portion of the water, waiting for it to be absorbed in the soil, and then applying the next portion).
- Use less water (about half as much) in shaded areas than in open sun.
- Remove thatch in spring if it is more than 0.5 inch thick.

Fertilization

Proper fertilization of turfgrass is an important component in producing vigorous, dense growth. Low fertility, especially low nitrogen, is one of the factors that allows weeds to invade turf. For example, clovers tend to grow well in areas of low soil nitrogen because they can fix nitrogen in their roots. Therefore, where clovers are a problem, increase nitrogen fertilization to make the turfgrass more competitive. Most turfgrass species require a total of 4-6 lbs of actual nitrogen per 1000 square feet per year. Apply nitrogen about four times during the year when the turf is actively growing (see Table 2). For slow-release fertilizers, make applications at 6- to 8-week intervals; for other fertilizers, applications are made at 4- to 6-week intervals. Use the following guidelines to determine application rates for the different turfgrass species:

TABLE 2.

Nitrogen requirements and periods of active growth of cool- and warm-season turfgrass species.

Turfgrass Species	Nitrogen (lb/1000 sq ft/application)[1]	Period of Active Growth[2]
COOL-SEASON TURF		
bentgrass, colonial	0.5	Mar–Jun and Sep–Nov
bentgrass, creeping	0.75-1	Mar–Jun and Sep–Nov
fescue, fine	0.25–0.5	Mar–Jun and Oct–Dec
fescue, tall	0.5-1	Mar–Jun and Sep–Dec
Kentucky bluegrass	0.5-1	Mar–May and Oct–Dec
ryegrass, annual (for overseeding)	0.75	Oct–May
ryegrass, perennial	0.5–1	Feb–Jun and Oct–Dec
WARM-SEASON TURF		
bermudagrass, common	0.5 (spring–summer)	Apr–Sep
bermudagrass, hybrid	0.75–1	Apr–Sep
Tifgreen	0.75–1	Apr–Sep
Tifway II	0.75–1	Apr–Sep
Santa Ana	0.75–1	Apr–Sep
dichondra	1	Apr–Oct
kikuyugrass	0.5	Feb–Nov
St. Augustinegrass	0.5	Mar–Oct
zoysiagrass	0.25–0.5	Apr–Oct

[1] Assuming 4 applications per year during period of active growth

[2] Varies slightly according to location in the state.

Mowing

Correct mowing height and frequency of mowing is critical for preventing weed invasion. Different turfgrass species have different mowing height requirements. Mowing Kentucky bluegrass too short (less than 1.5 inches) weakens the turf and encourages weed growth. Conversely, mowing it too high (higher than 3 inches) reduces turf density and competitive ability. The table below provides the correct mowing height for the different turfgrass species.

Turfgrass species	Mowing height (inches)
bentgrass, colonial	0.5–1
bentgrass, creeping	0. 5 or less
bermudagrass, common	1–1.5
bermudagrass, hybrid	
Tifgreen	0.25–0.5
Tifway II	0.5–1
Santa Ana	0.5–1
dichondra	not mowed
fescue, fine	1.5 or not mowed
fescue, tall	2-3
Kentucky bluegrass	1.5–2.5
kikuyugrass	1-1.5
ryegrass, annual	1.5–2.5
ryegrass, perennial	1.5–2.5
St. Augustinegrass	1-2
zoysiagrass	0.5–1.5

Mow turfgrass so that no more than one-third of the leaf blade is taken off at each cutting. In the summer months, cool-season turfgrasses (Kentucky bluegrass, perennial ryegrass, fine fescue, tall fescue and colonial bentgrass) may be mowed at the higher height to encourage deeper rooting.

Weedy turfgrass areas need to be mowed frequently so that they don't develop a patchy appearance caused by uneven growth of the weeds. Common weeds that require frequent mowing to prevent patchiness and seedhead development are annual bluegrass and annual ryegrass in winter and crabgrass, dallisgrass, and nutsedge in summer.

Thatch Removal and Aeration

Thatch develops in turfgrass when dead leaves, rhizomes, stolons, and stems accumulate faster than they are decomposed. Creeping species such as bentgrass, bermudagrass, zoysiagrass, St. Augustinegrass, and kikuyugrass can produce a thick thatch. Removing thatch increases the turfgrass vigor, reduces scalping by the mower, and gives a more uniform appearance to the turfgrass. Thatch can reduce the effectiveness of preemergence herbicides by either (1) binding with the herbicides and making them ineffective or (2) increasing degradation of the herbicides as a result of the increased activity of microorganisms living in the thatch.

Thatch removal (by verticutting) should be done before preemergence herbicides are applied; otherwise the herbicide will be removed or its activity will be decreased. The same principle applies to aeration. Apply herbicides after aeration to get maximum control of the weeds.

MONITORING

Regular weed surveys (winter, spring, and summer) will help determine what species are present, their approximate population levels, and what types of management practices may be necessary. Use *Weeds of the West*, UC ANR Publication 3350; *Weeds of California*, UC ANR Publication 3488; the UC IPM online *weed photo gallery* at http://ipm.ucdavis.edu/PMG/weeds_common.html, or the UC IPM online Guide to Healthy Lawns http://ipm.ucdavis.edu/TOOLS/TURF/.

Use a form such as the following one to keep written records of monitoring results. (This form can also be adapted to use in a spreadsheet computer program.) A written weed history will aid in making future weed management decisions.

WEED SURVEY FORM

Date _____ Location _____

ANNUAL SPECIES		
( ) annual bluegrass	( ) knotweed	( ) scarlet pimpernel
( ) black medic	( ) large crabgrass	( ) smooth crabgrass
( ) burclover	( ) malva	( ) spotted spurge
( ) common chickweed	( ) pineappleweed	( ) spurweed
( ) goosegrass	( ) purslane	( ) wild barley
( ) _____	( ) _____	( ) _____
PERENNIAL SPECIES		
( ) bermudagrass	( ) English daisy	( ) oxalis
( ) broadleaf plantain	( ) green kyllinga	( ) nutsedge, purple
( ) dallisgrass	( ) kikuyugrass	( ) nutsedge, yellow
( ) dandelion	( ) _____	( ) white clover
( ) _____	( ) _____	( ) _____

( ) Check for frequency of occurrence: L = low, M = medium, H = high frequency.

HERBICIDES

Herbicides are an effective tool where high quality turf is desired. However, they must be applied with care and accuracy and in the context of a good overall turf management program. Before using any herbicide, carefully review the label for conditions of use including rates, methods of application, and precautions. Never use an herbicide in any manner contrary to its label and be sure that the herbicide will not injure the turfgrass species (see table on *Sensitivity of Turf Species to Herbicides*).

When using any herbicide for the first time, apply it at the recommended rate on a limited area to make sure it is successful under local conditions. Excessive rates, improper timing, or application errors of selective herbicides can injure or kill desirable turf. Insufficient application, on the other hand, usually results in failure or incomplete weed control. Be aware of formulation changes for the herbicide; new formulations may result in turf injury even though no injury was noted in previous formulations.

In some cases adjuvants are used with herbicides. Adjuvants are compounds that modify a spray solution. These include wetting agents, surfactants, spreaders, emulsifiers, and solvents. Adjuvants can enhance herbicide activity and/or reduce herbicide selectivity. Some adjuvants alone can cause injury to turf. Adjuvants should only be used when called for by the product label.

Herbicides can be broadcast or used for spot treating areas. The extent of the weed infestation will determine which application method to use. Broadcast applications can be made either by spraying herbicides mixed in water or by applying herbicides fixed to granules. Small, scattered weed infestations should be controlled with spot applications. Larger more uniform weed infestations should be controlled with broadcast applications. To increase the uniformity of granular applications apply one-half of the required herbicide over the entire area to be treated in one direction (north-to-south) and the other half over the entire area in the perpendicular direction (east-to-west). Before making broadcast spray applications, carefully calibrate the sprayer to insure accuracy. See *The Safe and Effective Use of Pesticides*, UC ANR Publication 3324 for additional information.

Spot treatment with selective herbicides such as 2,4-D is useful in small areas. Be sure to apply the recommended rate and concentration. Be careful not to prolong application over individual spots as over-application can occur and result in turf injury to the surrounding area. Spot treatments are also useful with nonselective herbicides such as glyphosate when used to control individual clumps of weeds such as tall fescue, dallisgrass, smutgrass, or nutsedge. When applying the herbicide, apply just enough spray to wet the leaves of the weed. Do not allow the application equipment to drip or leak between spot applications. Also, do not walk through the treated area onto untreated turf. Severe turf injury can result from the herbicide dripping onto the turfgrass or by being moved on the soles of shoes. If the weed is taller than the turf, the herbicide can be applied with a sponge or wick wiper, giving a selective application to the weed.

Site Preparation

Three herbicides that can be used before planting turfgrass (preplant) are glyphosate (Roundup Pro), dazomet (Basamid), and metam sodium (Vapam). When preparing a new site for turfgrass, glyphosate, a systemic herbicide, is used primarily for control of existing perennial weeds. Dazomet and metam sodium are soil fumigants that are usually applied to bare soil. Vaporproof coverings like polyethylene will increase the control from the soil fumigants dazomet and metam sodium. Preplant fumigation of a site can kill bermudagrass, nutsedge, and other perennials, as well as all existing annual plants and many germinating seeds.

Newly Established Turf

Siduron (Tupersan) can be used on newly seeded or established, cool-season turfgrass for control of broadleaf seedlings and warm-season grasses. DCPA (Dacthal) can be used "at greening" when a solid stand of turf is apparent. Bromoxynil (Buctril) can be applied to newly emerged turf when it is about one month old to control seedling broadleaf weeds. Postemergence herbicides such as 2,4-D, dicamba, fluroxypyr, or triclopyr can be used for broadleaf control once the turf has produced several tillers and has been mowed two or three times. In general, preemergence herbicides can be used when the turfgrass is well established; there are a few exceptions for earlier usage, such as Dacthal.

Established Turf

Herbicides may be applied before (preemergence) or after (postemergence) weeds emerge. Each herbicide may have restrictions on certain species of turfgrass, usage sites (e.g. recreational, commercial, or residential turf), and availability to purchase (e.g. licensed applicator). Always read and follow the label recommendations. Weed control is often rate dependent. More information about each herbicide is included in the HERBICIDE TREATMENT TABLE.

Putting two or more herbicides into the same spray tank is called a tank mix and is a common practice in several turfgrass situations. Tank mixes can be two preemergences, two postemergence, or one of each kind. Herbicide labels suggest or specifically list which herbicides can be tank mixed with a product. For tank mixes, observe all directions for use on all labels, and employ the most restrictive limits and precautions. Never exceed the maximum active ingredient (a.i.) on any label when tank mixing products that contain the same a.i.

There are dozens of formulations and combinations of herbicides that are sold as a prepackaged mix in the turfgrass marketplace. These products are designed to increase the weed spectrum of activity, or the safety to the turfgrass species or site, or both. These guidelines do not list all herbicide products because they are too numerous and change too rapidly, however their active ingredients remain fairly constant and are described here. These mixes typically include various combinations of the following: 2,4-D or 2,4-DP, dicamba, MCPA, MCPP, MSMA, carfentrazone, triclopyr, fluroxypyr, and quinclorac.

Preemergence herbicides used to control weeds in turf are applied to the soil before the weed seeds germinate; most are moved into the top 1 to 3 inches of soil by rain or irrigation where they will be taken up by the roots and shoots of the emerging weeds. Timing of application and sprinkler irrigation afterwards are key to achieving the

best results. Soil residual activity depends upon the herbicide and rate of application. The general range of activity is 2 to 8 months with most herbicides lasting about 3 to 4 months. Preemergence herbicides include:

Atrazine (Atrazine), which is labeled for use in sod production only, is used exclusively in St. Augustinegrass or zoysiagrass for control of annual broadleaf weeds and some annual grasses.

Bensulide (Bensumec) is used on many species of established turf for control of annual grasses. Apply it before initial weed seed germination; the timing of the application depends on location in the state and the weed species targeted. Bensulide gives 4 to 6 months control of annual grasses and will inhibit germination of overseeded grass.

DCPA (Dacthal) is one of the safest herbicides for most turf species. It is used principally for crabgrass and annual bluegrass control, but will also give short-term control of several broadleaf weeds including prostrate (spotted) spurge, speedwell, chickweed, knotweed, little mallow, and purslane.

Dithiopyr (Dimension) is used on many species of established turf for control of annual grass and some seedling broadleaf weeds. Used primarily as a preemergence herbicide to control germinating crabgrass, annual bluegrass, spurge, and oxalis, but it will also control crabgrass (large or smooth) seedlings up to the 3-leaf stage. May be combined with MSMA for postemergence crabgrass control.

Ethofumesate (Poa Constrictor, Prograss) is a translocated, selective herbicide that controls several annual grass and broadleaf weeds. Primary use is annual bluegrass management. It has both preemergence and early (two-leaf stage) postemergence activity and is most effective in programs that use both timings. May be used on home lawns, golf courses (not putting greens), and is safe for most turfgrasses except zoysia and fine fescue. Must be applied by a licensed applicator.

Isoxaben (Gallery) is used on many species of established turf for the control of many broadleaf weeds. Apply it in late summer to early fall for winter annuals or in early spring for summer annuals or perennial weed seedlings. Provides 6 to 8 months of control.

Napropamide (Devrinol) effectively controls crabgrass and many other annual weeds before emergence. It is currently registered on dichondra, warm-season turf and tall fescue.

Oryzalin (Surflan) controls annual grasses and some broadleaf weeds in warm-season turf and tall fescue. Although labeled for use in tall fescue, oryzalin should not be applied to tall fescue under stress or roots will be inhibited. For this reason, other preemergence herbicides are recommended. Because it has long residual activity; a summer application may prohibit germination of a fall overseeding of winter annual grass.

Oryzalin+benefin (XL 2G) is a granular formulation that combines two dinitroaniline preemergence herbicides for increased weed-spectrum activity.

Oxadiazon (Ronstar) has three formulations with different restrictions in turfgrass. Ronstar G is registered for use in landscape and established warm-season and most cool-season turf species. Ronstar 50 WSP and Ronstar FLO are registered for landscape sites and only dormant bermudagrass, St. Augustine, and zoysiagrass. Oxadiazon is a good preemergence for annual broadleaf and grass weed control. Primarily used for crabgrass, annual bluegrass, annual ryegrass and bromegrasses. Controls many broadleaf weeds including groundsel and other composites, shepherd's purse and other mustards, and little mallow (malva). It is fairly effective on spurge and creeping woodsorrel but does not control chickweed. Ronstar's mode of action is different from most other preemergence herbicides that are root inhibitors. Ronstar is a shoot inhibitor, which is useful on newly sprigged bermudagrass, when spread by creeping stems and root formation is desirable. Ronstar may be used in fairways, parks, golf courses, and non-residential lawns. It is not registered for use on home lawns and should not be used on golf greens. It is only available to licensed applicators.

Pendimethalin (Pre-M, Pendulum, Pendulum AquaCap) is used on many species of established turf to control many broadleaf and grass weeds including crabgrass, foxtail, annual bluegrass, oxalis, and spurge. Because of its long residual period, the turf should not be overseeded with grasses for 8 to 12 weeks after application.

Prodiamine (Barricade) is used on many species of established turfgrass to control annual grasses and many broadleaf weeds, including oxalis and spurge. It is very insoluble in water and lasts for a long time, giving good control. It will interfere with overseeding of grasses for 4 to 10 months, depending on the rate used. Turfgrass must be well established before prodiamine is used or roots will be inhibited.

Pronamide (Kerb) is selective herbicide used for preemergence or early postemergence control of annual bluegrass in bermudagrass turf. It is also used to remove perennial ryegrass from warm-season turf, especially bermudagrass during spring transition at 50% greenup. This herbicide is also effective on chickweed. Pronamide is not registered for use on residential lawns and is only available to licensed applicators.

Siduron (Tupersan) is a preemergence herbicide that can be applied at planting, on newly planted, or established cool-season turfgrass (fescue, bluegrass or ryegrass) to control seedlings of warm-season weeds, particularly crabgrass, bermudagrass, or kikuyugrass. Its primary use is in turf renovation where bermudagrass or kikuyugrass is killed with glyphosate and a cool-season grass is planted. This product is only available to licensed applicators, but it can be used on homeowner lawns.

Pre- and Postemergence Herbicides

There are several herbicides for use in turfgrass that have both pre- and postemergence weed control activity. They are dithiopyr, ethofumesate, and pronamide. Their descriptions are listed under the category of main usage.

Postemergence herbicides

Postemergence herbicides used in turfgrass weed control either translocate systemically or act as contact herbicides. Herbicides that translocate penetrate the leaves and stems, move in the vascular system, and eventually reach a site of action where they interfere with plant processes, ultimately killing the weeds. Herbicides that translocate include 2,4-D, MCPA, fluazifop, glyphosate, mecoprop, and MSMA. Some translocated herbicides such as dicamba, fluroxypyr, and triclopyr also have some soil activity and can be taken up by roots. Contact herbicides like bromoxynil, carfentrazone, and bentazon kill only the plant tissues touched by the spray, although bentazon does have some soil activity. Movement within the plant beyond the point of contact is limited. Both types of postemergence herbicides must pass through the leaves or shoots of the plant. Some herbicides are rainfast in as little as 2 hours while others should not be irrigated or rained on for at least 48 hours after application. A surfactant (adjuvant) is often added to foliar sprays to help penetrate leaves. Apply to actively growing weeds, and hold off on mowing several days in advance of postemergence herbicide applications.

Bentazon (Bentazon, Broadloom) is a contact herbicide with some soil activity. It helps to control yellow nutsedge and selected broadleaf weeds in turf. Repeated applications are necessary for best results.

Bispyribac-sodium (Velocity) is a selective postemergence herbicide for control of annual bluegrass, roughstalk bluegrass, and certain broadleaf weeds in golf courses and sod farms. It is used in creeping bentgrass and perennial ryegrass (permanent, not overseeded).

Bromoxynil (Buctril) is a contact herbicide used for the control of many young broadleaf weeds. It is the least phytotoxic of the postemergence herbicides to newly seeded grass, yet controls broadleaf weeds when they are small seedlings. It can also be used in established turfgrass but not bentgrass greens. May be tank mixed with other broadleaf herbicides such as 2,4-D, MCPP, dicamba, or MSMA to increase the spectrum of weed control.

Carfentrazone (QuickSilver) is a contact broadleaf herbicide that causes a quick burndown of weeds when temperatures are moderately warm. Control is still achieved in cold weather but takes longer. Does not control chickweed. Can be used in cool- and warm-season turfgrasses. It is also labeled for moss control. Often sold as a prepackaged mix (Power Zone, Speedzone) with other systemic, broadleaf weed killers such as 2,4-D, MCPA, MCPP, or dicamba.

Chlorsulfuron (Corsair) controls many broadleaf weeds, including wild carrot, wild garlic, and wild onion. Control of weed species is rate dependent. Can be used on all turfgrass species except tall fescue, ryegrass, and dichondra, though some precautions are necessary for turfgrass safety. This herbicide is only available to licensed applicators but may be used on home lawns.

Clopyralid (Lontrel) is a translocated, broadleaf herbicide that primarily controls weeds in three plant families: the bean and pea family (which includes clovers), the nightshade family, and the sunflower family (which includes dandelion, composites and thistles). It is particularly effective on hard-to-control thistles, such as yellow starthistle. It is combined and packaged with triclopyr (Confront) for control of additional broadleaf weeds. Clopyralid use is restricted to golf courses only where clippings will not be used in off-site composting. Clopyralid is also packaged and sold in combination (Millenium Ultra 2) with other postemergence herbicides (2,4-D, dicamba, and MSMA).

Dicamba (Banvel) is a foliar-applied, translocated, broadleaf herbicide that also has soil activity. Do not apply high rates or make repeated applications over the root zones of susceptible shrubs and trees. Spray dicamba on calm days to avoid drift onto susceptible plants. Can be used in cool- and warm-season grasses. Often packaged and sold in combination with other broadleaf weed killers (2,4-D, MCPP, triclopyr) to increase the spectrum of weed control.

Ethofumesate (Poa Constrictor, Prograss) is a translocated, selective herbicide that controls several annual grass and broadleaf weeds. Primary use is annual bluegrass management. It has both preemergence and early (two-leaf stage) postemergence activity and is most effective in programs that use both timings. May be used on home lawns, golf courses (not putting greens), and is safe for most turfgrasses except zoysia and fine fescue. Must be applied by a licensed applicator.

Fluazifop (Fusilade II, Ornamec) is a translocated, selective herbicide that controls most annual and perennial grasses, but will not control annual bluegrass. Annual grasses are easiest to control when young. Higher rates of application and repeat treatments are necessary for control of perennial grasses. Its effectiveness is reduced when grasses are under moisture stress. It is used primarily to control grassy weeds in broadleaf ground covers, including dichondra. This herbicide will injure most turfgrass species and is used primarily to suppress bermudagrass in tall fescue. A non-ionic surfactant must be added to the spray tank.

Fluroxypyr (Vista) is a translocated, selective herbicide that controls several broadleaf weeds including clovers, medics, and creeping woodsorrel in most established warm- and cool-season turf species. This herbicide is fast acting and may injure bermudagrass at higher rates. Do not use on golf course putting greens or tees. Do not use near tree or shrub roots, suckers, or shallow-rooted woody plants or injury will occur. Do not tank mix with 2,4-D amine formulation.

Foramsulfuron (Revolver) selectively removes cool-season grasses (annual bluegrass, perennial ryegrass, tall fescue, etc.) growing in established bermudagrass and zoysiagrass. It also suppresses dallisgrass. For use by licensed applicators only.

Glyphosate (Roundup, KleenUp) is a translocated, nonselective herbicide used for broad-spectrum weed control. Apply it to rapidly growing young annual weeds or to perennial weeds at the flowering stage. This herbicide will injure all turfgrass species and is primarily used to control weeds before planting or in turfgrass renovation.

Halosulfuron (Sedgehammer) is a translocated, selective, postemergence herbicide used for the control of yellow and purple nutsedge and the suppression of green kyllinga. It will require more than one application for control and needs a nonionic surfactant in the spray solution. Safe for use in all established turfgrasses.

MCPA is a translocated, broadleaf herbicide. When used at the same rate as 2,4-D, it is less effective in the control of most weed species but somewhat safer for the turfgrass. It is often mixed with mecoprop and dicamba to increase its effectiveness.

MCPP **or** ***mecoprop*** (Mecomec) is a translocated, broadleaf herbicide. Because of its selectivity, it is generally safer to use on turfgrass than 2,4-D or triclopyr and is the safest postemergence herbicide to use on bentgrass. Controls chickweed, clovers, pearlwort, and prostrate knotweed. Frequently formulated into broadleaf herbicide mixes with 2,4-D and dicamba, but also MSMA, triclopyr, carfentrazone, and quinclorac.

MSMA (MSMA 6) is a selective, translocated herbicide. It is used principally for crabgrass, dallisgrass, nutsedge, and green kyllinga control. It is effective on a couple of broadleaf weeds. May cause temporary discoloration of turf. The degree of MSMA selectivity on turf is determined by temperature and rate. Bermuda, bluegrass, and zoysia are most tolerant. Bentgrass and fescues are moderately tolerant. Do not use MSMA on St. Augustinegrass, red fescue, or dichondra. Use is severely restricted so read the label carefully. Product use will be prohibited after December 31, 2013.

Quinclorac (Drive) is a selective, translocated herbicide for control of many broadleaf and grass weeds. It is primarily used to control clovers and large crabgrass (results are inconsistent on smooth crabgrass) and to limit the growth of kikuyugrass in warm-season turfgrass. Tips on mowing and adjuvants are specified. Often formulated and combined with other broadleaf weed herbicides.

Sulfosulfuron (*Certainty*) is a postemergence, translocated herbicide primarily used in warm-season turf. It controls annual and perennial sedges (including purple and yellow nutsedge and green kyllinga), cool-season

grasses (*Poa annua*, *Poa trivialis*, perennial ryegrass, and tall fescue), and broadleaf weeds (including chickweed, dandelion, white clover, and lawn burweed) growing in established warm-season turfgrasses including bermudagrass, St. Augustinegrass, zoysiagrass, centipede, and kikuyugrass. It can be used to control *Poa trivialis* (roughstalk bluegrass) in creeping bentgrass and Kentucky bluegrass; to remove tall fescue from Kentucky bluegrass; and to remove perennial ryegrass from overseeded bermudagrass. It can be used in fairways, commercial and residential lawns, parks, and sod farms.

Triclopyr (Turflon) is a translocated herbicide used to control several broadleaf weeds; it is especially effective on creeping woodsorrel (oxalis) and clovers. Do not use triclopyr on bentgrass or warm-season turf species such as common and hybrid bermudagrasses and kikuyugrass. It is sometimes used in tall fescue lawns to suppress bermudagrass. It has some soil activity, so do not apply high rates or make repeated applications over the root zones of shrubs and trees.

Trifloxysulfuron (Monument) is a selective, translocated herbicide used to control annual sedges, yellow and purple nutsedge, green kyllinga, oxalis, and spurge. It also suppresses crabgrass and dallisgrass. It is harmful to cool-season turfgrass species, so it is used in spring greenup to remove tall fescue, annual and perennial rye, annual bluegrass (*Poa annua*), and roughstalk bluegrass (*Poa trivialis*) from bermudagrass, St. Augustinegrass, and zoysiagrass. It can only be used on golf courses, sod farms, and other non-residential turf, such as cemeteries and commercial building sites.

2,4-D is a selective herbicide used for annual and perennial broadleaf weed control. It is applied in spring when weeds are rapidly growing. Additional treatments may be required for late emerging weeds or on perennials. This herbicide is available as an amine or ester formulation. The 2,4-D ester form is used for hard-to-kill perennial broadleaf weeds. Do not use it on newly seeded turf, St. Augustinegrass, bentgrasses, or dichondra. The amine form is generally more selective on turfgrass and is less subject to drift problems to nontarget species. 2,4-D is often mixed with several other broadleaf weed killers (MCPP, MCPA, dicamba, clopyralid, carfentrazone, MSMA, triclopyr, quinclorac, etc.) to increase the spectrum of susceptible weeds or provide safety to turfgrass species or sites, or both.

Plant growth regulators

Plant growth regulators can be applied postemergence for weed control

Paclobutrazol (Trimmit) is a plant growth regulator that suppresses the growth of warm- and cool-season grasses. It can only be applied when the desirable turfgrass is actively growing. Some grasses (e.g. *Poa annua)* can be more retarded in growth than other grasses (e.g. bermudagrass), leading to selective control after prolonged use.

Mefluidide (Embark) is a plant growth regulator used for *Poa* seedhead control in golf courses.

SPECIAL WEED PROBLEMS (9/09)

ANNUAL BLUEGRASS

Annual bluegrass is a cool-season grass that germinates when soil temperatures are less than 70°F. It is especially prevalent in wet areas. Several preemergence herbicides will control annual bluegrass including bensulide, DCPA, dithiopyr, oryzalin, oxadiazon, pendimethalin, and prodiamine. Ethofumesate also will control annual bluegrass after emergence, but it must be applied to very young seedlings. Bispyribac, foramsulfuron, and sulfosulfuron also have postemergence activity but application sites are limited. Seed production by this weed can be suppressed with a plant growth regulator, such as paclobutrazol or mefluidide.

BERMUDAGRASS

Although bermudagrass is used as a turfgrass, its rapid growth by stolons into other turfgrass areas makes it a weed in those situations. Bermudagrass is a perennial that is commonly found throughout California. It spreads by seed and by stem sections (rhizomes and stolons). The rhizomes and stolons are many jointed and root at the nodes. Avoid spreading stem sections of bermudagrass with mowers and other turf maintenance equipment to uninfested areas. Bermudagrass does not grow well in the shade. Fall and winter fertilization and high mowing heights (greater than 1.5 inches) will reduce bermudagrass invasion into cool-season turf. Preemergence herbicides (pendimethalin, siduron) will aid in the control of germinating bermudagrass seedlings. Postemergence herbicides (fluazifop, quinclorac, and triclopyr) suppress bermudagrass invasion in cool-season tall fescue, but repeated applications are needed.

CALIFORNIA BURCLOVER AND BLACK MEDIC

California burclover and black medic are annual or short-lived perennial broadleaf weeds that infest turf. Invasion by these two species is encouraged by low nitrogen fertility. Herbicides that control these annual species include clopyralid, dicamba, fluroxypyr, mecoprop, quinclorac, or triclopyr.

CRABGRASS

Two species of crabgrass that commonly infest turf in California are smooth crabgrass and large crabgrass. Both species are annuals that spread primarily by seed, and to a lesser extent, by rooting at swollen nodes of stems. Crabgrass is frequently a problem in overirrigated turf. Frequent, shallow irrigation encourages the establishment of crabgrass. Preemergence applications of products containing bensulide, DCPA, dithiopyr, napropamide, oryzalin, oxadiazon, pendimethalin, and prodiamine control crabgrass. Siduron can give some control when cool-season grasses are planted in spring. Postemergence applications of products containing MSMA will aid in the control of crabgrass.

Crabgrass is a common, warm-season, annual grass weed in California turf. In warmer parts of the state (southern CA) it may germinate throughout the year. In cooler parts of the state (northern CA) it has a shorter germination period and growing season. In most areas of California, the major germination period starts from late January to mid-March, depending on the weather, and seeds continue to germinate throughout the spring and summer. While germination is early in warm winter areas, growth is slow during spring months until the weather warms. In June and July the plants produce tillers, shoots, and flowers in late July and August. Crabgrass may overwinter in warm areas and produce new growth and a second crop of seed in spring or early summer. For best control, apply preemergence herbicides 2 to 3 weeks before expected germination. In general this occurs before the end of January in warm winter areas of southern California, by mid-February in the Central Valley and Central Coast, and from mid-February to March 1 for northern California and the North Coast area. The optimum application period for postemergence herbicides is before flowering when the weed is actively growing.

CREEPING WOODSORREL (OXALIS)

Creeping woodsorrel is a perennial broadleaf weed that is often found in well maintained turf areas. Creeping woodsorrel grows year round in California and has leaves similar to those of clover. It spreads by seed and by creeping stems that root at the nodes. It is a difficult weed to control once established. There are no cultural controls available for this weed. Preemergence herbicides containing dithiopyr, isoxaben, pendimethalin, or prodiamine will limit emergence. In cool-season turf, postemergence treatments with triclopyr controls creeping woodsorrel. This weed is not controlled by 2,4-D. In warm-season turfgrasses, combinations of 2,4-D, MCPP, and dicamba plus MSMA or carfentrazone are fairly effective, just be sure to use mixtures developed for warm-season turfgrasses. Applications with fluroxypyr are also effective, just be sure to follow label rates. Applications of both pre- and postemergence herbicides are generally needed to provide satisfactory control of creeping woodsorrel for several months in both cool- and warm-season turfgrasses.

DALLISGRASS

Dallisgrass seed germinates in spring and summer and it becomes a perennial plant with the formation of short rhizomes. It has a clumpy growth habit that gives turf an irregular surface unsuitable for most sports activities. Repeated postemergence treatment with MSMA or nonselective spot treatment with glyphosate can reduce dallisgrass infestations. Foramsulfuron suppresses dallisgrass in bermudagrass and zoysiagrass. To control seedlings use a preemergence herbicide such as those listed for crabgrass.

DANDELION

Dandelion is a perennial broadleaf weed with a persistent, fibrous-fleshy taproot. Removal of the leaves and 1 to 2 inches of taproot will not control dandelion because it regenerates from the remaining portion of the taproot. Poorly maintained open turf areas allow the establishment of dandelion. Frequent mowing to remove the flowers will reduce the spread of viable seeds. Seedlings can be controlled with DCPA, isoxaben, or napropamide before they emerge. Postemergence treatment with 2,4-D, fluroxypyr, and triclopyr will control dandelion; products containing MCPA, MCPP, and quinclorac also work but are less effective. Dicamba is not effective for controlling this weed.

ENGLISH DAISY

English daisy is a perennial broadleaf weed that is most common in cool coastal climates, especially in some golf courses. It has smooth, succulent-like leaves and thick fleshy rhizomes, which become woody under close mowing. Regrowth from rhizomes is common as is spread by seed. Plants are easier to control with herbicides at higher rather than lower mowing heights.

GOOSEGRASS (SILVER CRABGRASS, WIREGRASS)

Goosegrass seedlings are often confused with crabgrass, but goosegrass germinates later in spring, is darker green, grows in tufts, and has a white or silvery color near the flattened stem bases. This annual weed is normally found on compacted soils or areas of heavy wear. Crabgrass preemergence herbicides have been successful in the control of goosegrass.

GREEN KYLLINGA

Green Kyllinga, a small perennial sedge, is a prolific seed producer that also spreads by rhizomes. It has been found in the southern coastal counties, the Sacramento region, and the Fresno area. It is becoming more widespread and is often found in areas that are frequently irrigated, have standing water, or where soil remains wet. Repeated applications of MSMA, halosulfuron, or sulfosulfuron work well, but combinations of halosulfuron or sulfosulfuron plus MSMA seem to be the best control.

KIKUYUGRASS

Like bermudagrass, kikuyugrass is a perennial weed that is found in south and central coastal counties and in parts of the Sacramento and San Joaquin valleys. Frequently, kikuyugrass is mistaken for St. Augustinegrass. A quick way to tell them apart is to examine their leaves: kikuyugrass has pointed leaves with hairy stems, St. Augustinegrass has short, blunt leaves with no hairs. Most cultural practices will not reduce kikuyugrass invasion. Repeated postemergence applications of MSMA will reduce kikuyugrass in warm-season turf. Repeated triclopyr or triclopyr plus MSMA applications have controlled kikuyugrass invasions into cool-season turf. Repeated applications of quinclorac alone or in combination with MSMA have limited kikuyugrass spread in warm-season turfgrass.

NUTSEDGE

Yellow and purple nutsedge, sometimes called nutgrass, are serious perennial weeds in turf. Both produce an extensive system of underground tubers from which they can regenerate. Nutsedge, especially purple, is very difficult to control once it is established in turf. When establishing turf, try to plant in seedbeds that are free of nutsedge. Small localized infestations of nutsedge can be controlled with nonselective materials such as glyphosate applied in repeated applications. Purple and yellow nutsedge can be reduced in turf with multiple postemergence applications of products containing halosulfuron, sulfosulfuron, and trifloxysulfuron or multiple applications of MSMA. Bentazon is effective on yellow but not purple nutsedge. To minimize nutsedge invasion maintain a uniform, competitive turf and avoid overly wet soil.

PLANTAIN

Both broadleaf and narrowleaf (buckhorn) plantains are found as weeds in turf. Buckhorn plantain can act as an annual, biennial, or perennial weed, whereas broadleaf plantain is a perennial. Poorly maintained open areas in turf encourage the establishment of plantain. Postemergence treatment with broadleaf weed killers containing 2,4-D, MCPP, dicamba, or quinclorac in two or three way combinations or applications with products containing fluroxypyr or triclopyr will control these weeds. Buckhorn plantain is more tolerant of drought but less tolerant of compaction than is broadleaf plantain.

SMUTGRASS

Smutgrass, a perennial, spreads by seed and quickly becomes established. Control at first indication with spot treatments of glyphosate or fluazifop. Germinating seeds can be controlled with preemergence herbicides used for crabgrass control.

SPOTTED (PROSTRATE) SPURGE

Spurge is an annual broadleaf weed that germinates in open spaces from March through October. It can be a problem in closely mowed turf that has open areas. Preemergence applications of products containing DCPA, dithiopyr, isoxaben, oryzalin, oryzalin plus benefin, pendimethalin, or prodiamine are very helpful in limiting the establishment of spurge. Postemergence applications of products containing bromoxynil or triclopyr have been helpful in the control of spurge. Two or three way combinations of postemergence broadleaf weed killers in combination with carfentrazone or quinclorac are also successful in the control of spurge. In addition, raising the mowing height and increasing fertility helps make the turf more competitive against this weed.

WHITE CLOVER

White clover is a low-growing perennial broadleaf that roots at nodes along its stems. It produces white flowers that attract bees to turf areas. It develops readily in turf that is low in nitrogen, so to make the turfgrass more competitive apply nitrogen fertilizer in spring and fall for cool-season turf and in summer months for warm-season turfgrasses. Postemergence application of clopyralid, dicamba, mecoprop, quinclorac, or triclopyr will control white clover.

COMMON and SCIENTIFIC NAMES OF WEEDS (9/09)

Common name	Scientific name
Barnyardgrass	*Echinochloa crus-galli*
Bermudagrass	*Cynodon dactylon*
Bluegrass, annual	*Poa annua*
Bluegrass, roughstalk	*Poa trivialis*
Brassbuttons, Mexican	*Cotula mexicana*
Brassbuttons, southern	*Cotula australis*
Burclover, California	*Medicago polymorpha*
Chamomile, mayweed	*Anthemis cotula*
Burweed, lawn (soliva)	*Soliva sessilis*
Catsear, common	*Hypochaeris radicata*
Chickweed, common	*Stellaria media*
Chickweed, mouseear	*Cerastium fontanum* subsp. *vulgare*
Clover, white	*Trifolium repens*
Crabgrass, large	*Digitaria sanguinalis*
Crabgrass, smooth	*Digitaria ischaemum*
Cudweed, purple	*Gnaphalium purpureum*
Daisy, English	*Bellis perennis*
Dallisgrass	*Paspalum dilatatum*
Dandelion	*Taraxacum officinale*
Dock, curly	*Rumex crispus*
Filarees	*Erodium* spp.
Foxtail, yellow	*Setaria pumila*
Geranium, cutleaf	*Geranium dissectum*
Goosegrass	*Eleusine indica*
Healall(selfheal)	*Prunella vulgaris*
Henbit	*Lamium amplexicaule*
Kikuyugrass	*Pennisetum clandestinum*
Knotweed, common	*Polygonum arenastrum*
Knotweed, prostrate	*Polygonum aviculare*
Kyllinga, green	*Kyllinga brevifolia*
Mallow, little(cheeseweed)	*Malva parviflora*
Medic, black	*Medicago lupulina*
Nutsedge, purple	*Cyperus rotundus*
Nutsedge, yellow	*Cyperus esculentus*
Pearlwort, birdseye	*Sagina procumbens*
Pimpernel, scarlet	*Anagallis arvensis*

(continued next page)

Common name	Scientific name
Pineappleweed	*Chamomilla suaveolens*
Plantain, broadleaf	*Plantago major*
Plantain, buckhorn	*Plantago lanceolata*
Purslane, common	*Portulaca oleracea*
Ryegrass, Italian	*Lolium multiflorum*
Smutgrass	*Sporobolis indicus*
Sorrel, red	*Rumex acetosella*
Speedwell, Persian	*Veronica persica*
Spurge, spotted	*Euphorbia maculata*
Swinecress, lesser	*Coronopus didymus*
Velvetgrass, German	*Holcus mollis*
Wild carrot	*Daucus carota*
Wild celery	*Cyclospermum leptophyllum*
Wild garlic	*Allium vineale*
Woodsorrel, creeping	*Oxalis corniculata*
Yarrow, common	*Achillea millefolium*

SENSITIVITY OF TURF SPECIES TO HERBICIDES (9/09)

	PREEMERGENCE												
	ATR	BES	CHL	DCP	DIT	ISO	NAP	ORY	OXA	PEN	PRD	PRO*	SID
TURF SPECIES													
bentgrasses	s	T	T	r	r	—	s	s	s	s	s	s	R
bermudagrass, common	r	T	T	T	T	T	T	R	T	T	T	T	s
bermudagrass, hybrid	r	T	—	T	T	T	t	r	T	T	T	T	s
bluegrass, Kentucky	s	T	T	T	T	T	r	s	T	R	R	s	T
dichondra	s	T	s	s	—	—	T	t	s	t	r	r	—
fescue, fine	s	T	—	T	R	—	T	s	T	T	T	s	R
fescue, tall	s	T	s	T	T	T	t	s	T	T	T	s	T
kikuyugrass	—	t	T	t	—	—	r	—	r	r	t	—	s
ryegrasses	s	T	s	T	—	T	r	s	R	r	T	s	T
St. Augustinegrass	t	T	R	T	—	T	s	T	R	—	—	s	s
zoysiagrass	T	T	R	T	—	T	r	s	R	R	T	s	T

UPPER CASE LETTERS = Registered for this turf species in California

	POSTEMERGENCE																					
	BIS	BTZ	BRO	CAR	CHL	CLO	DIC*	ETH[1]	FLU	FLX	FOR	GLY	HAL	MEC	MSM	PEX	PRO*	QUI	SUL	TRS	TRY	24A*	24E*
TURF SPECIES																							
bentgrasses	R	r	r	T	T	t	R	T	s	R	s	s	T	T	s	R	s	R	R	s	s	r	s
bermudagrass, common	T	T	T	T	T	t	T	R[2]	s	R	T	s	T	T	T	T	T	T	T	T	r	T	T
bermudagrass, hybrid	T	T	T	T	—	t	T	R[2]	r	R	T	s	T	T	T	T	T	R	T	s	s	T	T
bluegrass, Kentucky	s	T	T	T	T	t	T	T	s	T	s	s	T	T	R	T	s	T	T	s	T	T	T
dichondra	—	s	s	s	s	T	s	s	T	s	—	s	—	s	s	s	r	s	s	s	s	s	s
fescue, fine	—	T	T	T	—	t	T	s	T	R	s	s	T	T	T	—	s	T	T	s	T	T	T
fescue, tall	—	T	T	T	s	t	T	T	s	T	s	s	T	T	t	R-S	s	R	T	s	T	T	T
kikuyugrass	—	—	t	—	T	—	r	—	s	?	R	s	—	r	s	T	—	s	r	s	s	t	r
ryegrasses	R	T	T	T	s	t	T	T	s	T	s	s	T	t	T	R-S	s	T	T	s	T	T	T
St. Augustinegrass	—	T	R	T	R	—	s	T	—	R	R	s	T	t	s	—	s	s	s	s	s	s	s
zoysiagrass	—	T	t	T	R	t	R	s	s	T	T	s	T	r	T	—	s	T	s	T	s	r	s

UPPER CASE LETTERS = Registered for this turf species in California

S = sensitive R = relatively tolerant T = tolerant — = no information

ATR = atrazine (Drexel Atrazine)
BES = bensulide (Bensumec)
BIS = bispyribac sodium (Velocity)
BRO = bromoxynil (Buctril)
BTZ = bentazon (Bentazon, Broadloom)
CAR = carfentrazone (QuickSilver)
CHL = chlorsulfuron (Corsair)
CLO = clopyralid (Lontrel)
DCP = DCPA (Dacthal)
DIC = dicamba* (Banvel)
DIT = dithiopyr (Dimension)
ETH = ethofumesate (PoaConstrictor, Prograss)
FLU = fluazifop (Fusilade II)
FLX = fluroxypyr (Vista)
FOR = foramsulfuron (Revolver)
GLY = glyphosate (Roundup)
HAL = halosulfuron (Sedgehammer)
ISO = isoxaben (Gallery)
MEC = mecoprop (MCPP)
MSM = MSMA
NAP = napropamide (Devrinol)
ORY = oryzalin (Surflan)
OXA = oxadiazon (Ronstar)
QUI = quinclorac (Drive)
PEN = pendimethalin (Pendulum, etc.)
PEX = penoxulam (Saphire)
PRD = prodiamine (Barricade)
PRO = pronamide(Kerb)
SUL = sulfosulfuron (Certainty)
TRS = trifloxysulfuron (Monument)
TRY = triclopyr (Turflon)
24A = 2,4-D amine*
24D = 2,4-D*
24E = 2,4-D ester*

* Permit required from county agricultural commissioner for purchase or use.

1 See label for varietal tolerance of each turf species. Injury may occur to certain species or cultivars.

2 For use on dormant bermudagrass only.

SUSCEPTIBILITY OF WEEDS IN TURFGRASS TO HERBICIDE CONTROL[Φ] (12/16)

	PREEMERGENCE														
	ATR	BEN	DCP	DIT	IND	ISO	MES	NAP	ORY	OXA	PEN	PRD	PRO	SID	SUF
ANNUAL WEEDS															
barnyardgrass	C	C	C	C	C	N	C	C	C	P	C	C	C	C	C
bluegrass, annual	C	C	C	C	C	N	P	C	C	C	C	C	C	N	C
brassbuttons, southern	—	—	—	—	C	—	—	—	—	—	—	—	—	N	—
burclover, California	C	N	N	—	C	C	—	C	P	C	P	P	N	N	—
burweed, lawn (soliva)	C	N	N	—	C	—	—	C	P	C	P	P	N	N	C
celery, wild	—	—	—	—	—	—	—	—	—	—	—	—	—	N	—
chickweed, common	C	N	P	C	C	C	C	C	C	N	C	C	C	N	C
crabgrass, large	P	C	C	C	C	N	C	C	C	C	C	C	C	C	C
crabgrass, smooth	P	C	C	C	C	N	C	C	C	C	C	C	C	C	C
cudweed	C	N	N	—	C	C	—	N	N	N	N	N	N	N	N
filarees	P	N	P	—	C	C	—	C	P	C	N	N	N	N	—
foxtail, yellow	P	C	C	C	C	N	C	C	C	C	C	C	C	C	C
geranium, cutleaf	—	N	N	P	—	C	—	—	C	—	C	C	—	N	C
goosegrass	P	C	P	P	C	N	—	P	C	P	C	C	P	N	C
henbit	C	N	N	P	C	C	—	N	P	C	P	P	—	N	C
knotweed, prostrate	C	N	P	C	C	C	—	C	C	C	C	C	C	N	C
mallow, little (cheeseweed)	C	N	N	—	C	—	—	P	P	C	P	P	P	N	—
mayweed (chamomile)	—	—	—	—	C	—	—	—	—	—	—	—	—	N	—
medic, black	C	N	N	—	C	C	—	N	N	N	N	N	N	N	C
pearlwort, birdseye	—	N	—	—	—	C	—	—	C	N	C	—	—	N	—
pimpernel, scarlet	C	N	C	—	—	C	—	C	C	C	C	C	—	N	—
pineappleweed	C	N	N	C	—	—	—	P	N	C	N	P	N	N	N
purslane, common	C	N	C	C	C	C	C	C	C	C	C	C	C	N	C
ryegrass, Italian	P	C	P	C	C	N	—	P	C	N	C	C	C	N	C
speedwell, Persian	—	N	P	—	C	C	C	—	C	—	C	C	—	N	C
spurge, spotted (prostrate)	C	N	P	C	C	C	—	N	C	P	C	P	N	N	C
swinecress, lesser	—	N	N	—	C	—	—	C	—	—	P	—	N	N	—
PERENNIAL WEEDS															
bermudagrass, common (seedling)	C	C	C	C	—	N	—	C	C	C	C	C	—	C	C
bermudagrass, common (established)	N	N	N	N	N	N	N	N	N	N	N	N	N	P	N
brassbuttons, Mexican	—	—	—	—	—	—	—	—	—	—	—	—	—	N	—
carrot, wild	—	—	N	—	C	—	C	—	N	—	—	N	N	N	—
catsear, common	P	N	N	N	P	N	—	N	N	N	N	N	N	N	—
chickweed, mouseear	P	N	N	N	C	N	C	N	N	N	N	N	N	N	C
clover, white	P	N	N	N	C	N	C	N	N	N	N	N	N	N	—
daisy, English	N	N	N	N	N	N	—	N	N	N	N	N	N	N	—
dallisgrass (seedling)	C	C	C	C	—	N	—	C	C	C	C	C	C	N	C
dallisgrass (perennial)	N	N	N	N	N	N	—	N	N	N	N	N	N	N	N
dandelion (seedling)	C	N	C	P	C	C	—	C	N	—	N	N	N	N	N
dandelion (perennial)	N	N	N	N	N	C	—	N	N	N	N	N	N	N	N
dock, curly (seedling)	C	N	C	—	C	C	—	P	P	—	C	C	C	N	N
dock, curly (perennial)	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

	PREEMERGENCE														
	ATR	BEN	DCP	DIT	IND	ISO	MES	NAP	ORY	OXA	PEN	PRD	PRO	SID	SUF
garlic, wild	—	—	—	—	—	—	—	—	—	—	—	—	—	N	N
healall (selfheal)	N	N	N	N	—	N	—	N	N	N	N	N	N	N	N
kikuyugrass	N	N	N	N	—	N	N	N	N	N	N	N	N	—	N
knotgrass	N	N	N	N	—	N	N	N	N	N	N	N	N	—	N
kyllinga, green	P	C	C	C	P	C	N	C	C	C	C	C	P	N	N
nutsedge, purple	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
nutsedge, yellow	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
plantains (seedling)	C	N	N	—	C	—	C	—	—	—	—	—	N	N	N
plantains (perennial)	P	N	N	N	—	N	N	N	N	N	N	N	N	N	N
smutgrass	C	N	P	C	—	C	—	C	C	C	C	C	C	—	N
sorrel, red	P	N	N	N	—	N	—	N	N	N	N	N	N	N	N
velvetgrass, German	N	N	N	N	—	N	—	N	N	N	N	N	N	—	N
woodsorrel, creeping	C	N	N	N	C	N	—	N	N	N	N	N	N	N	N
yarrow, common	N	N	N	N	—	N	—	N	N	N	N	N	N	N	—

C = control, P = partial control, N = no control, — = no information

Φ Susceptibility tables are based on limited UC research and information from labels.

* Permit required from county agricultural commissioner for purchase or use.

ATR = atrazine (Atrazine)
BEN = bensulide (Bensumec)
DCP = DCPA (Dacthal Flowable)
DIT = dithiopyr (Dimension)
IND = indaziflam (Specticle)
ISO = isoxaben (Gallery)
MES = mesotrione (Tenacity)
NAP = napropamide (Devrinol)
ORY = oryzalin (Surflan)
OXA = oxadiazon (Ronstar)
PEN = pendimethalin (Pre-M, Pendulum)
PRD = prodiamine (Barricade)
PRO = pronamide (Kerb)
SID = siduron (Tupersan)
SUF = sulfentrazone (Dismiss CA)

	POSTEMERGENCE																							
	BIS	BTZ	BRO	CAR	CLO	DIC*	ETH	FLU	FLX	FOR	GLY	HAL	MEC	MES	MSM	PEX	PRO	QUI	SUF	SUL	TRS	TRY	24A*	24E*
ANNUAL WEEDS																								
barnyardgrass	—	N	N	N	N	N	P	C	N	N	C	N	N	C	C	—	C	N	N	—	—	N	N	N
bluegrass, annual	C	N	N	N	N	N	C	N	N	C	C	N	N	N	N	—	C	N	N	C	C	N	N	N
brassbuttons, southern	—	—	—	—	—	—	—	—	—	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—
burclover, California	—	—	N	—	C	C	—	N	—	N	C	N	C	—	N	—	—	C	C	—	C	P	P	P
burweed, lawn (soliva)	C	—	C	—	C	P	—	N	C	N	C	—	C	C	N	—	—	—	C	C	C	—	C	C
celery, wild	—	—	—	—	—	—	—	—	—	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—
chickweed	C	—	P	P	C	C	C	N	C	N	C	N	C	C	N	—	C	—	C	C	C	P	P	C
crabgrass, large	—	N	N	N	N	N	P	C	N	N	C	N	N	C	C	—	C	P	N	—	P	N	N	N
crabgrass, smooth	—	N	N	N	N	N	P	C	N	N	C	N	N	C	C	—	C	P	N	—	P	N	N	N
cudweed	—	N	N	—	—	C	C	N	P	N	C	N	C	—	N	—	N	—	C	—	—	—	N	P
filarees	—	—	C	—	P	C	P	P	—	N	P	—	—	—	N	—	N	—	C	—	—	—	C	C
foxtail, yellow	—	N	N	N	N	N	C	P	N	N	C	N	N	C	—	—	C	N	N	—	—	N	N	N
garlic, wild	—	—	—	—	—	—	—	—	—	N	—	—	—	—	—	—	—	—	C	C	C	—	—	—
geranium, cutleaf	—	—	—	—	—	C	—	N	—	N	C	N	C	—	N	—	—	—	C	C	C	C	C	C
goosegrass	—	N	N	N	N	N	N	C	N	P	C	N	N	C	C	—	C	N	P	—	—	N	N	N
henbit	C	C	—	—	C	C	P	N	C	P	C	N	C	C	N	—	C	—	C	C	C	—	P	C
knotweed, prostrate	—	—	—	—	—	C	C	N	C	N	P	N	C	—	N	—	C	—	C	—	—	—	P	C
mallow, little (cheeseweed)	—	—	C	C	C	C	P	N	—	N	P	N	C	—	N	—	P	—	C	—	—	—	C	C
mayweed (chamomile)	—	—	—	—	—	—	—	—	—	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—
medic, black	—	—	N	—	C	C	—	N	C	N	P	N	C	—	N	—	—	C	C	—	C	C	P	P
pearlwort, birdseye	—	—	—	—	—	C	—	N	—	N	C	—	C	—	N	—	—	—	—	—	—	—	—	—
pimpernel, scarlet	—	—	—	—	—	C	—	N	—	N	C	—	C	—	N	—	—	—	—	—	—	C	C	C
pineappleweed	—	N	P	N	C	C	P	N	—	N	C	—	N	—	N	—	N	—	C	—	—	—	P	P
purslane, common	—	C	C	N	—	C	C	N	C	N	C	—	C	C	N	—	C	—	C	—	—	C	C	C
ryegrass, Italian	—	N	N	N	N	N	N	C	N	C	P	—	N	—	N	—	C	N	N	C	C	N	N	N
speedwell, Persian	—	—	—	N	—	—	—	N	C	N	C	—	—	C	—	—	—	—	C	—	—	N	N	N
spurge, spotted (prostrate)	—	—	C	—	—	P	N	N	C	N	C	—	P	—	N	—	P	—	C	—	C	C	P	P
swinecress, lesser	C	—	C	—	—	P	N	N	—	N	C	—	N	C	—	—	N	—	—	—	—	—	N	N
PERENNIAL WEEDS																								
bermudagrass, common (seedling)	—	N	N	N	N	N	—	C	N	N	C	N	N	—	N	—	—	—	N	—	—	C	—	—
bermudagrass, common (established)	—	N	N	N	N	N	N	P	N	N	C	N	N	—	N	—	N	—	N	—	—	P	—	—
brassbuttons, Mexican	—	—	—	—	—	—	—	—	—	N	—	—	—	—	—	—	—	—	—	—	—	—	—	—
carrot, wild	—	—	—	—	P	C	—	N	C	N	C	—	—	C	—	—	N	—	—	—	—	—	—	—
catsear, common	—	N	N	—	C	C	—	N	C	N	C	N	P	C	N	—	—	—	—	—	—	—	C	C
chickweed, mouseear	—	N	N	P	C	C	—	N	—	N	C	N	C	C	N	—	C	—	C	—	C	—	P	P
clover, white	C	N	N	—	C	C	C	N	C	N	P	N	C	C	N	C	N	C	—	C	—	C	P	P
daisy, English	—	N	N	N	P	P	—	N	—	N	C	N	N	—	N	C	N	N	—	—	—	N	N	N

	POSTEMERGENCE																						
	BIS	BTZ	BRO	CAR	CLO	DIC*	ETH	FLU	FLX	FOR	GLY	HAL	MEC	MES	MSM	PEX	PRO	QUI	SUF	SUL	TRS	TRY	24A*	24E*
dallisgrass (seedling)	—	N	N	N	N	P	—	—	N	N	C	N	N	—	C	—	C	—	N	P	P	C	—	—
dallisgrass (perennial)	—	N	N	N	N	N	N	N	N	N	C	N	N	—	C	—	N	—	N	P	P	N	—	—
dandelion (seedling)	C	N	C	—	C	C	—	N	C	N	C	—	C	C	N	—	N	—	C	C	C	N	—	—
dandelion (perennial)	C	N	N	—	P	P	N	N	C	N	C	—	N	C	N	—	N	—	C	C	C	N	—	—
dock, curly (seedling)	—	N	C	—	C	C	—	N	C	N	C	—	C	C	N	—	C	—	C	—	—	C	—	—
dock, curly(perennial)	—	N	N	—	P	C	N	N	C	N	P	—	P	C	N	—	N	—	C	—	—	P	—	—
healall (selfheal)	—	N	N	—	—	P	—	N	—	N	C	N	—	C	N	—	—	—	—	—	—	P	N	N
kikuyugrass	—	N	N	—	N	N	—	C	N	N	C	N	N	—	P	—	—	P	N	—	—	N	N	N
knotgrass	—	N	N	—	—	N	—	C	N	N	C	N	N	—	N	—	—	—	N	—	—	N	N	N
kyllinga, green	—	N	N	—	N	N	—	N	N	N	C	P	N	—	P	—	—	N	C	C	C	N	N	N
nutsedge, purple		N	N	N	N	N	P	N	N	N	P	C	N	—	P	—	N	N	C	C	C	N	N	N
nutsedge, yellow	C	P	N	N	N	N	P	N	N	N	P	C	N	C	P	—	N	N	C	C	C	N	N	P
plantains (seedling)	C	N	C	—	N	C	N	N	C	N	C	—	C	—	N	—	N	—	C	—	—	—	—	—
plantains (perennial)	C	N	N	—	N	P	N	N	C	N	P	—	P	—	N	—	N	—	C	—	—	N	—	—
red sorrel	—	N	N	—	C	C	—	N	—	N	C	N	N	—	N	—	—	—	C	—	—	—	N	N
smutgrass	—	—	—	—	—	C	—	N	N	N	P	N	C	—	N	—	—	—	N	—	—	—	P	C
velvetgrass, German	—	N	N	—	N	N	—	P	N	N	C	N	N	—	N	—	—	—	N	—	—	N	N	N
woodsorrel, creeping	P	N	N	—	N	N	—	N	C	N	C	N	P	P	N	—	—	—	C	—	C	C	N	N
yarrow, common	—	N	N	—	—	C	—	N	—	N	C	N	P	—	N	—	—	—	—	—	—	—	P	C

C = control, P = partial control, N = no control, — = no information

Φ Susceptibility tables are based on limited UC research and information from labels.

*Permit required from county agricultural commissioner for purchase or use.

BIS = bispyribac sodium (Velocity)
BRO = bromoxynil (Buctril)
BTZ = bentazon (Bentazon, Broadloom)
CAR = carfentrazone (QuickSilver)
CLO = clopyralid (Lontrel)
DIC* = dicamba (Banvel)
ETH = ethofumesate (PoaConstrictor, Prograss)
FLU = fluazifop (Fusilade II)
FLX = fluroxypyr (Vista)
FOR = foramsulfuron (Revolver)
GLY = glyphosate (Roundup)
HAL = halosulfuron (Sedgehammer)
MEC = mecoprop (MCPP)
MES = mesotrione (Tenacity)
MSM = MSMA
PEX = penoxsulam (Sapphire)
PRO = pronamide (Kerb)
QUI = quinclorac (Drive)
SUF = sulfentrazone (Dismiss CA)
SUL = sulfosulfuron (Certainty)
TRS = trifloxysulfuron (Monument)
TRY = triclopyr (Turflon)
24A* = 2,4-D amine
24E* = 2,4-D ester

HERBICIDE TREATMENT TABLE (12/16)

Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

The following are listed alphabetically. When choosing a pesticide, consider information relating to environmental impact, resistance management, the pesticide's properties, and application timing. Not all registered pesticides are listed. Always read the label of the product being used.

PREPLANT

A.	DAZOMET*	275 lb a.i./acre or 7.92 oz a.i./100 sq ft		
	(Basamid G)	277 lb/acre or 8 oz/100 sq ft	See label	—

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 27
COMMENTS: Soil-applied, granular fumigant for control of annual weeds. Apply directly to the soil and mix 6 inches deep with a power tiller. Activity is better if irrigated after tilling in. Vaporproof tarping also improves weed control. Better on sandy soils than on clay soils. Can seed in 3 weeks if temperature is over 60ºF and soil is moist but not wet.

B.	METAM SODIUM*	160–319.5 lb a.i./acre or 3.67–7.33 lb a.i./1000 sq ft		
	(Vapam HL)	37.5–75 gal/acre	See label	—

COMMENTS: Preirrigate soil so seeds and juvenile perennial propagules absorb water. Apply as soil begins to dry; soil temperature should be at least 50ºF at 1 inch for best results. Rototilling before treatment will enhance control. Can apply by sprinkler, drip, soil injection, or by soil bedding equipment. Certified applicators must have successfully completed a special "Soil Fumigant Training Program" and follow MANDATORY GOOD AGRICULTURAL PRACTICES (GAPs) as stipulated on the label. Apply in water on calm day; follow immediately with sprinkler irrigation to seal the soil surface or, preferably, cover with vaporproof covering (sometimes mandatory). Seed in 2 weeks on light sandy soils, in 3 to 4 weeks on heavier clay or organic soils. Extend waiting period if temperature is below 60ºF. Two applications are usually required to eradicate bermudagrass, nutsedge, or kikuyugrass. Fumigants such as metam sodium are a prime source of volatile organic compounds (VOCs), which are a major air quality issue.

. . . or . .

	METAM POTASSIUM: POTASSIUM N-METHYLDITHIOCARBAMATE**	160–319.5 lb a.i./acre or 3.67–7.33 lb a.i./1000 sq ft		
	(K-Pam HL)	30–62 gal/acre	See label	—

COMMENTS: Preirrigate soil so seeds and juvenile perennial propagules absorb water. Apply as soil begins to dry; soil temperature should be at least 50ºF at 1 inch for best results. Rototilling before treatment will enhance control. Can apply by sprinkler, drip, soil injection, or by soil bedding equipment. Certified applicators must have successfully completed a special "Soil Fumigant Training Program" and follow MANDATORY GOOD AGRICULTURAL PRACTICES (GAPs) as stipulated on the label. Apply at least 14 to 21 days before a new crop is planted. Cultivation should be done 5 to 7 days after treatment if planting is to occur within 14 to 21 days after treatment. Test treated soil before planting. Tarping may be required in some parts of CA. Fumigants such as K-Pam HL are a prime source of volatile organic compounds (VOCs), which are a major air quality issue.

C.	GLYPHOSATE	2–4 lb a.i.		
	(Roundup Weathermax)	1.7–3.5 qt	4	Until dry
	(Roundup Pro)	2.66–5.33 qt	4	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9
COMMENTS: Glyphosate is a nonselective, foliar-applied postemergence herbicide that will eliminate nearly all established weeds and turf species from a site before seedbed preparation. It has no preemergence activity on emerging weeds or turf species. Use the lower rate for annual weeds and the higher rate for perennial weeds. Apply to actively growing weeds that are not stressed. Little mallow, burning nettle, and filarees are only partially controlled; some Conyza species, such as horseweed (marestail) and hairy fleabane, have developed resistance to glyphosate.

POSTPLANT • BEFORE WEEDS EMERGE (PREEMERGENCE HERBICIDES)

A.	ATRAZINE*	1–2 lb a.i.		
	(Drexel Atrazine 4L)	2–4 pt	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 5

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	COMMENTS: Used for control of annual broadleaf weeds and some annual grasses in bermudagrass, centipedegrass, St. Augustine, or zoysiagrass turf. Do not use on other turf types or injury will result. Labeled for fairways, commercial and residential lawns, and sod farms. May be applied up to 30 days before cutting or lifting sod. Do not apply in light textured (sandy) soils where tree or shrub roots may absorb the herbicide. Restricted use pesticide due to ground and surface water contamination concerns.			
B.	BENSULIDE (Bensumec) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 8 COMMENTS: Primarily used for preemergence control of annual grasses in most species of established turfgrasses (except bentgrass in CA). It can also be used in dichondra at seeding or any time thereafter. It is only available to certified applicators, but it can be applied to residential lawns as well as golf courses. Not for use in parks, recreational areas, or other public sites. Water in immediately after application with 0.5 to 1 inch of water. For annual bluegrass, crabgrass, or goosegrass control, apply 2 to 3 weeks before initial germination. If treating for both annual bluegrass and annual, warm-season grass weeds, then up to three properly timed applications may be needed per year. Rates of application are dependent upon the number of applications made per year. The maximum label rate is 18 fl oz per 1000 sq ft per year in two or more applications, depending on the weed species and the degree of infestation.	7.5–10 lb a.i. 1.875–2.5 gal	0	Until dry
C.	DCPA (Dacthal Flowable) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3 COMMENTS: Apply to many species of established turfgrass before annual weeds germinate. For crabgrass control apply in late winter 2 to 3 weeks before initial crabgrass germination. Exact timing varies by location in California (Jan. for southern California, early to mid-Feb. for Central Valley and Central Coast area, and mid-Feb. to March 1 for Northern California). For annual bluegrass control, apply at the end of Aug. or early Sept. Also controls several broadleaf weeds. Incorporate with 0.5 inch water as soon as possible and at least within 3 to 5 days after application. Early spring applications may be made to new turfgrass seedlings after the grasses have exhibited a uniform greening of the newly sprouted grass, preferably when 1 to 2 inches in height. These applications control crabgrass without injury to newly emerged grass. Only Dacthal Flowable is labeled for use in Ornamental Turf (golf courses, athletic fields, cemeteries, parks, non-residential lawns, institutional areas, and sod farms). Do not use on golf course greens or low mowed bentgrass, or dichondra. Wait at least 60 days before overseeding. Dacthal W-75 (75% wettable powder) formulation is no longer registered for use in turfgrass.	10 lb a.i. 13.33 pt	12	—
D.	DITHIOPYR (Dimension 2EW) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3 COMMENTS: Apply to many species of established turf 2 to 3 weeks before annual weeds germinate. Apply in late winter to early spring for crabgrass, spurge, and oxalis, or in fall for annual bluegrass. May be applied as a single application in spring or fall, or as a split application with half being applied in spring and half in fall. Do not apply more than 1.5 lb a.i. per year. Has postemergence activity on crabgrass seedlings up to the 5-leaf stage. Do not apply within 3 months of seeding, overseeding, or sprigging. Labeled for use in most turfgrass sites including residential lawns. Do not use on golf course putting greens. Safe for use in most turfgrass species, however a few cultivars are sensitive. Consult label for specific turf restrictions.	0.25–0.5 lb a.i. 1–2 pt	12	Until dry
E.	ETHOFUMESATE (Prograss, Poa Constrictor) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 8 COMMENTS: A translocated, selective herbicide that controls several annual grass and broadleaf weeds. Primary use is annual bluegrass management. Has both preemergence and early (two-leaf stage) postemergence activity and is most effective in programs that use both timings. May be used on home lawns, golf courses (not putting greens) and is safe for most turfgrasses (except zoysiagrass and fine fescue) but must be applied by a licensed applicator. See label for cultivar tolerances of turf species.	Label rates	12	Until dry
F.	INDAZIFLAM (Specticle 20WSP or Specticle Flo) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 29 COMMENTS: For use on established warm-season grasses only. Not safe for cool-season turfgrasses (including tall fescue) or kikuyugrass. A preemergence herbicide with some postemergent activity. Controls annual grasses, annual sedges, and many broadleaf weeds by inhibiting root development. Limited early postemergence activity on annual bluegrass, crabgrass, and oxalis is enhanced with 0.5% v/v methylated seed oil. Labeled for established turf areas including golf courses (roughs and fairways), athletic fields, residential and commercial lawns, parks, cemeteries, and sod farms. To move the herbicide into the soil: apply 0.25 inch water within 2 days after application. Provides long season weed control, so do not reseed for 8 to 12 months.	Label rates	12	Until dry

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
G.	ISOXABEN	0.5–0.9975 lb a.i.		
	(Gallery 75 DF)	0.66–1.33 lb	12	Until dry
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 21			
	COMMENTS: Apply to many species of established turf in late summer or early fall before winter annual weeds germinate. Provides 6 to 8 months of control of many broadleaf weeds including: henbit, speedwells, oxalis, brassbuttons, and knotweed. A spring application helps control spurge and other summer broadleaf annuals. Follow application with at least 0.5 inch water. Not for use on putting greens or grass grown for seed.			
H.	MESOTRIONE	Label rates	12	Until dry
	(Tenacity)			
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 27			
	COMMENTS: A systemic preemergence and postemergence herbicide for the selective contact and residual control of weeds in mostly cool-season turfgrass species. When applied, preemergence weeds absorb the herbicide during emergence from the soil. Activate with 0.15 inch water within 10 days of preemergence application. Primarily used postemergence to remove crabgrass and yellow nutsedge from cool-season grasses. Two postemergence applications with a non-ionic surfactant are needed. When used postemergence, susceptible weeds absorb the herbicide through foliar contact and soil absorption. Weed growth ceases and then foliage turns white due to loss of chlorophyll; death may take up to 3 weeks. Can also cause temporary whitening of turfgrass foliage. Symptoms appear 5 to 7 days after application and last for several weeks. However a repeat application to the same site causes less whitening of the plant tissue. Can also be used preemergence when renovating or seeding cool-season grasses. Labeled for use in golf courses (except putting greens), athletic fields, parks, cemeteries, commercial and residential lawns, and sod farms. Consult the label for turfgrass species restrictions.			
I.	NAPROPAMIDE	2–3 lb a.i.		
	(Devrinol 50DF)	4–6 lb	24	—
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 15			
	COMMENTS: Apply at seeding or on established dichondra; can also be used on bermudagrass, St. Augustinegrass, and tall fescue. Principally for control of weedy grasses but will control some broadleaf weeds. A split application of 2 lb a.i. can be applied for crabgrass and 2 lb a.i. for goosegrass; apply 8 to 10 weeks apart. Apply in early fall for annual bluegrass control. Follow applications with a minimum of 0.5 inch of water to wash material from the leaves and into the soil. Do not reseed or overseed within six months after application.			
J.	ORYZALIN	1.5–2 lb a.i.		
	(Surflan)	1.5–2 qt	See comments	Until dry
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3			
	COMMENTS: For use on warm-season grasses and tall fescue. Although labeled for use in tall fescue, oryzalin should not be applied to tall fescue under stress or roots will be inhibited. For this reason, other preemergence herbicides are recommended. Apply on established turf 2 to 3 weeks before annual weeds germinate. Use low rate of application for annual bluegrass control in late summer or early fall. Use high rate in late winter or early spring before germination of summer annual weeds. Do not aerate or verticut after application. Do not use on bluegrass, bentgrass, or ryegrass turf. Long residual from a summer application may prohibit fall overseeding of a cool-season grass in Bermuda turf. REI for Surflan is 24 hours.			
K.	ORYZALIN/BENEFIN	2–3 lb a.i.		
	(XL 2G)	100–150 lb	24	Until dust settles
	WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 3/3			
	COMMENTS: A granular formulation that combines two preemergence herbicides for increased weed activity in warm-season grasses and tall fescue. Apply on established turf before annual weeds germinate. Do not aerate or verticut after application. Do not use on bluegrass, bentgrass, or ryegrass.			
L.	OXADIAZON	2–4 lb a.i.		
	(Ronstar G)	100–200 lb	12	Until dry
	(Ronstar 50 WSP)	4–8 lb	12	Until dry
	(Ronstar Flo)	2.5–5 qt	12	Until dry
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14			
	COMMENTS: The granule formulation can be used safely on most grass species, but bentgrass has some restrictions. Some foliar injury may be observed if the granules are applied to wet foliage or the herbicide is not washed from the leaves after application. Apply these formulations at least 2 weeks before turf greens in spring. Is only fairly effective for control of prostrate spurge or creeping woodsorrel (*Oxalis*) in California, but does control many other broadleaf and grass weeds. Ronstar's mode of action is different from most other preemergence herbicides that are root inhibitors. Ronstar is a shoot inhibitor, which is useful on newly sprigged bermudagrass, when spread by creeping stems and root formation is desirable. Ronstar may be used in fairways, parks, golf courses, and non-residential lawns. Do not use on newly seeded dichondra or golf course greens. It is only available to licensed applicators.			
M.	PENDIMETHALIN	Label rates	24	Until dry

Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

(Pre-M 3.3 EC, Pendulum, Pendulum AquaCap)
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: Apply to many species of established turf 2 to 3 weeks before annual weeds germinate. Useful in the control of many broadleaf and grass weeds including: crabgrass, foxtail, creeping woodsorrel (oxalis), and spurge. Use lower rate for control of annual bluegrass in fall or as a split application for control of crabgrass or spurge in late winter and early summer. Do not aerate or verticut after application. Do not overseed with grasses for 8 to 12 weeks after application. Do not apply on bentgrass. Time application with rainfall or apply 0.5" irrigation as soon after application as possible.

N.	PRODIAMINE	0.65–1. 495 lb a.i.		
	(Barricade 65 WG)	1.0–2.3 lb	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: Unknown.
COMMENTS: Apply to many species of established turf 2 to 3 weeks before weeds germinate to control annual grasses and many broadleaf weeds, including creeping woodsorrel (oxalis) and spurge. It is very insoluble in water and lasts for a long time, giving good control. It will interfere with overseeding of grasses for 4 to 10 months, depending on the rate used. Turfgrass must be well established before use or roots will be inhibited. May thin turfgrass under stressed conditions, heavy wet soils, or shaded areas where growth is slow. Not for use on putting greens.

O.	PRONAMIDE	0.5–1.495 lb a.i.		
	(Kerb 50WP)	1–3 lb	24	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: Used for preemergence or early postemergence control of annual bluegrass in bermudagrass turf; the higher rate gives longer residual control. Do not use on seedling, newly sprigged, or newly sodded turf. Most effective in late fall at, or just before emergence. For postemergence control it takes 14 to 21 days before results are evident. Do not overseed with annual ryegrass within 90 days of treating with pronamide. Controls annual bluegrass slowly by inhibiting root development and thus reducing the weed vigor. Best control is accomplished when annual bluegrass is young and before seed head stage. Do not treat where the herbicide can move into sensitive cool-season grass species, do not apply to a bermudagrass turfgrass that has been overseeded with a cool-season grass, and do not overseed with cool-season species for 90 days following treatment. Also used during spring to selectively remove overseeded rye from warm-season grasses at 50% greenup. Not registered for use on residential lawns and only available to licensed applicators.

P.	SIDURON	2-6 lb a.i.		
	(Tupersan)	4–12 lb	4	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 7
COMMENTS: A preemergence herbicide that can be applied at planting, on newly planted or established cool-season turfgrass (fescue, bluegrass or ryegrass) to control seedlings of warm-season weeds, particularly crabgrass, bermudagrass, or kikuyugrass. Most cultivars of creeping bentgrass have shown tolerance to siduron. Can be used in golf courses (fairways, greens, aprons, and tees), ornamental lawns, parks, and sport facilities. Primarily used for turf renovation where bermudagrass or kikuyugrass are killed with glyphosate and a cool-season grass is planted. Available to licensed applicators but can be used on residential lawns. Siduron is only available to home gardeners as a weed and feed product for new lawns.

Q.	SULFENTRAZONE	Label rates.	NA	Until dry
	(Dismiss CA)			

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14
COMMENTS: Provides pre- and post-emergence control of many winter and summer annual broadleaf and grass weeds. Will suppress many sedges, including green kyllinga, and yellow and purple nutsedge. Safe for use in most turfgrass species. Can only be applied by licensed or certified applicator. Labeled for use in golf courses (fairways and roughs), athletic fields, commercial and residential lawns, and sod farms. Spray at 25 psi or less. Follow label directions for sprayer cleanout. Do not use with a surfactant or turf injury may occur. Preemergence activity is activated with 0.5 inch of water within 7 days after application and prior to weed germination.

POSTPLANT • BEFORE OR AFTER WEEDS EMERGE

There are a few herbicides for use in turfgrass that have both pre- and postemergence weed control activity. They are dithiopyr, ethofumesate, indaziflam, mesotrione, pronamide, and sulfentrazone. Their descriptions are listed under both categories.

POSTPLANT • AFTER WEEDS EMERGE (POSTEMERGENCE HERBICIDES)

A.	BENTAZON*	1 lb a.i.		
	(Bentazon 4, Broadloom)	1 pt	48	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 6

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	COMMENTS: Apply in 40 gal water/acre for yellow nutsedge in established turfgrass; thorough coverage is important. The nutsedge should be growing vigorously with good soil moisture. If control is not sufficient, apply a second treatment after 10 to 14 days. Do not apply more than 2 lb a.i. per season. For optimum control, do not mow 3 to 5 days before or after application. Do not use on newly seeded or sprigged turf or golf course greens. May be mixed with 2,4-D.			
B.	BISPYRIBAC-SODIUM (Velocity SG) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2 COMMENTS: A selective postemergence herbicide for control of annual bluegrass, roughstalk bluegrass, and certain broadleaf weeds in golf courses and sod farms. Used in creeping bentgrass and perennial ryegrass (permanent, not overseeded), fairways, and tees. Do not use on greens or roughs.	Label rates	12	Until dry
C.	BROMOXYNIL (Buctril) (Maestro) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 6 COMMENTS: Apply on young turfgrass after grass has emerged and when broadleaf weeds are in the 3- to 4-leaf stage or up to 6-inch weed height, or on rosette plants before they exceed 1.5 inches in diameter to control broadleaf weeds. On established turf, use lower rate on small weeds and higher rate on large weeds. During periods of high temperature, leaf tip burn may occur on turf. Do not use on bentgrass greens. Apply in at least 20 gal water/acre. May be tank-mixed with other broadleaf materials such as 2,4-D and 2,4-DP, MCPP, dicamba, or MSMA, (note that MSMA allowed uses have changed), or combinations of these materials, depending upon the weed species present.	0.25–0.5 lb a.i. 1–2 pt 0.5–1 pt	 See label See label	 Until dry Until dry
D.	CARFENTRAZONE (Quicksilver T & O) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14 COMMENTS: Controls a broad spectrum of annual and perennial broadleaf weeds in established turfgrass. May cause temporary yellowing of hybrid bermudagrass or tall fescue if under stress. Fast acting. A contact broadleaf herbicide that causes a quick burndown of weeds when temperatures are moderately warm. Control is still achieved in cold weather but takes longer. Does not control chickweed. Can be used in cool- and warm-season turfgrasses. It is also labeled for moss control. Often sold as a prepackaged mix (PowerZone, Speedzone) with other systemic broadleaf weed killers such as 2,4-D, MCPA, MCPP, or dicamba to control a broader spectrum of broadleaf weeds.	0.0311 lb a.i. 2 fl oz	 See label	 Until dry
E.	CARFENTRAZONE/MCPA/MCPP/DICAMBA* (Power Zone) WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 14/4/4/4 COMMENTS: Fast acting. A combination of 4 herbicides for control of a broader spectrum of annual and perennial broadleaf weeds in established turfgrass. May cause temporary yellowing of hybrid bermudagrass or tall fescue, especially if they are under stress.	Label rates	48	Until dry
F.	CLOPYRALID (Lontrel) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4 COMMENTS: A translocated broadleaf herbicide that controls weeds in the bean and pea family (e.g., clovers), nightshades, and the sunflower family (includes dandelion, most composites, and thistles). Particularly effective on hard to control thistles, such as yellow star thistle. Combined and packaged with triclopyr (Confront) for control of additional broadleaf weeds. Use is restricted to golf courses only where clippings will not be used in off-site composting. Used in cool- and warm-season grasses; apply to healthy well-established turf with well-anchored root system. Susceptible to leaching through soil, so avoid potential groundwater contamination in sensitive sites. Also packaged and sold as a mix (Millennium Ultra 2) with other postemergence, systemic broadleaf herbicides (2,4-D and dicamba).	Label rates	12	Until dry
G.	DICAMBA* (Banvel) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4 COMMENTS: A foliar-applied, translocated broadleaf herbicide that has soil activity. Apply in 40 gal water/acre for control of chickweeds, clovers, prostrate knotweed, pearlwort, red sorrel, curly dock, and suppression of English daisy. Do not apply more than two times per year. The 4 lb acid equivalent/gal formulation can also be used for spot spraying; do not exceed 0.5 lb acid equivalent/acre per season. Active through the soil; do not use where roots of ornamental plants may extend into treated area or spray on tree basins. Spray on calm days to avoid spray drift onto susceptible crops or ornamentals. Do not use on dichondra. Usually formulated in combination with other broadleaf weed herbicides (e.g., 2,4-D, MCPP, MCPA, triclopyr, carfentrazone, quinclorac).	0.25–0.5 lb a.i./100 gal water 0.5–1 pt	 24	 Until dry

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
H.	DITHIOPYR (Dimension 2EW)	0.38–0.5 lb a.i. 1.5–2 pt	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: A preemergence herbicide for many grass and broadleaf weeds with some postemergence activity on crabgrass if applied up to the 5-leaf stage (before tillering). Labeled for use in most turfgrass sites including residential lawns, but not golf course putting greens. Safe for use in most turfgrass species, however a few cultivars are sensitive. Consult label for specific turfgrass restrictions. Apply in late winter to early spring for crabgrass, spurge, and oxalis management. Do not apply within 3 months of seeding, overseeding, or sprigging.

I.	ETHOFUMESATE (Prograss, Poa Constrictor)	Label rates	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 8
COMMENTS: A translocated, selective herbicide that controls several annual grass and broadleaf weeds. Primary use is annual bluegrass management. Has both preemergence and early (two-leaf stage) postemergence activity and is most effective in programs that use both timings. May be used on home lawns, golf courses (not putting greens) and is safe for most turfgrasses (except zoysiagrass and fine fescue) but must be applied by a licensed applicator. See label for cultivar tolerances of turf species.

J.	FENOXAPROP P-ETHYL (Bayer Advanced Bermudagrass or Crabgrass Control for Lawns)	Label rates	NA	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1
COMMENTS: A residential use product, primarily used by homeowners or landscape maintenance workers with a Qualified Applicator Certificate (QAC) category Q. A translocated selective, postemergence herbicide that controls annual grass weeds growing in cool season turf species. It is used to remove crabgrass and suppress bermudagrass growing in fescue, ryegrass, and bluegrass lawns. Only available as a ready to use spray for certain species of residential lawns (Kentucky bluegrass, perennial ryegrass, and fescues).

K.	FLUAZIFOP (Fusilade II, Ornamec Over the Top)	Label rates	See comments	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 1
COMMENTS: A translocated, selective herbicide that controls most annual and perennial grasses but can be used to suppress common and hybrid bermudagrass in tall fescue and zoysiagrass. Will injure most other turfgrass species. Can also be used to renovate a non-fescue turf area. Will not control annual bluegrass. Apply when the grass is young and vigorous and has good soil moisture. Retreatments may be required for hard-to-kill weeds such as bermudagrass, dallisgrass, and kikuyugrass. Will not control nutsedge or green kyllinga. A non-ionic surfactant must always be added to the spray tank. Restricted entry interval for agricultural use for Fusilade is 12 hours; for Ornamec it is 4 hours. Fusilade II can only be used by commercial applicators and is not for use in residential lawns.

L.	FLUROXYPYR (Vista XRT)	Label rates	24	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4
COMMENTS: Fast acting translocated broadleaf herbicide that controls clovers, medics, oxalis and other broadleaf weeds in most established warm- and cool-season turf species (see label for turf species list). Some restrictions on bermudagrass. Do not use near tree or shrub roots, suckers, or shallow rooted plants to avoid injury. Labeled for use on most turfgrass sites, however do not use on golf course putting greens or tees. Most often combined with other postemergence broadleaf herbicides such as MCPA, 2,4-D, dicamba, and triclopyr and sold as Battleship III, Escalade 2, Medallion, Elliptical, etc. Do not allow spray drift to contact broadleaf ornamentals or injury may occur.

M.	FORAMSULFURON (Revolver)	Label rates	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
Selectively removes cool-season grasses (annual bluegrass, perennial ryegrass, tall fescue, etc.) growing in established bermudagrass and zoysiagrass. It also suppresses dallisgrass. For use by licensed applicators only.

N.	GLYPHOSATE (RoundUp, KleenUp, various)	Label rates	See label	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 9

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
	COMMENTS: A nonselective, translocated herbicide. Will injure all turfgrass species. Used primarily to control weeds before planting or in turfgrass renovation. Apply to rapidly growing weeds in 20 to 40 gal water/acre or as a spot treatment. For control of annual weeds shorter than 6 inches, apply 1 lb a.i./acre; if 6 inches or taller, apply 1.5 lb a.i./acre. Allow minimum of 3 days between application and renovation or cultivation. For control of perennial weeds, apply 4 to 5 lb a.i./acre to vigorous but nearly mature weeds (bermudagrass in summer-fall; field bindweed, at full bloom). In mowed turfgrass areas, do not mow before application. Delay verticutting, removing sod, or tillage for at least 7 days after treatment. To maximize control, allow the soil surface and root area to dry after verticutting or sod removal before replanting. When turfgrass or ornamentals are to be planted, a follow-up preemergence program is required to control the weed seeds.			
O.	HALOSULFURON	0.031–0.062 lb a.i.		
	(Sedgehammer)	0.66–1.33 oz/acre	12	Until dry
	(Sedgehammer+)	0.5–1 oz/ 1000 sq ft	12	Until dry
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2 COMMENTS: Apply to established turfgrass in summer for control of yellow and purple nutsedge, and green kyllinga suppression. For optimum control, do not mow 3 to 5 days before or after application. Usually requires two applications starting when sedge is in the 3- to 6-leaf stage followed 6 to 10 weeks later with the second application. Do not use more than two applications per season. This herbicide reacts slowly in the plant so do not expect immediate results. Use 0.25% nonionic surfactant for broadcast applications in equivalent to 100 gal water/acre (2 tsp/gal). Sedgehammer+ formulation includes a non-ionic surfactant in the formulation. Safe for use in cool- and warm-season turfgrass.			
P.	INDAZIFLAM	Label rates	12	Until dry
	(Specticle 20WSP, Specticle Flo) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 29 COMMENTS: For use on established warm-season grasses only. Not safe for cool-season turfgrasses (including tall fescue) or kikuyugrass. A preemergence herbicide with some postemergence activity. Controls annual grasses, annual sedges, and many broadleaf weeds by inhibiting root development. Limited early postemergence activity on annual bluegrass, crabgrass, and oxalis is enhanced with 0.5% v/v methylated seed oil. Labeled for established turf areas including golf courses (roughs and fairways), athletic fields, residential and commercial lawns, parks, cemeteries, and sod farms. To move the herbicide into the soil: apply 0.25 inch water within 2 days after application. Provides long season weed control, so do not reseed for 8 to 12 months.			
Q.	MCPA*			
	(MCPA Amine)	Label rates	48	Until dry
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4 COMMENTS: A translocated, broadleaf herbicide. When used at the same rate as 2,4-D is less effective in the control of most weed species but somewhat safer for the turfgrass. Often mixed, or only available in prepackaged mixes, with active ingredients such as mecoprop, dicamba, carfentrazone, or triclopyr to increase its effectiveness.			
R.	MCPA/TRICLOPYR/DICAMBA*			
	(Cool Power)	Label rates	0	0
	WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4/4/4 COMMENTS: A combination of three translocated, broadleaf herbicides. Used on golf courses, parks, residential and institutional turf lawns. Effective on dandelions, chickweeds, plantains, oxalis, spurge, and many other broadleaf weeds. Safe in cool-season turfgrasses, except bentgrass greens and tees), bermudagrass and zoysiagrass. St. Augustine is moderately tolerant. Not for use in dichondra. Applied to foliage, but also soil active so avoid spraying shrub and tree roots in lawns.			
S.	MECOPROP	Label rates	0	0
	(MCPP-P 4 Amine, Mecomec 2.5) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4 COMMENTS: A translocated, broadleaf herbicide for control of chickweed, clover, prostrate knotweed, pearlwort, and other broadleaf weeds. Spray on calm days to avoid spray drift onto susceptible crops or ornamentals. Safer to use on bentgrass than 2,4-D; do not use on dichondra. Use 1 qt surfactant per 100 gal spray. Frequently formulated into broadleaf herbicide mixes with 2,4-D and dicamba, but also MSMA, fluroxypyr, triclopyr, carfentrazone, or quinclorac.			
T.	MESOTRIONE	Label rates	12	Until dry
	(Tenacity) WSSA MODE-OF-ACTION GROUP NUMBER[1]: 27			

Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)

COMMENTS: A systemic preemergence and postemergence herbicide for the selective contact and residual control of weeds. Primarily used postemergence to remove crabgrass and yellow nutsedge from cool-season grasses. Two postemergence applications with a non-ionic surfactant are needed. When used postemergence, susceptible weeds absorb the herbicide through foliar contact and soil absorption. Weed growth ceases and then foliage turns white due to loss of chlorophyll; death may take up to 3 weeks. Can also cause temporary whitening of turfgrass foliage. Symptoms appear 5 to 7 days after application and last for several weeks. However a repeat application to the same site causes less whitening of the plant tissue. Labeled for use in golf courses (except putting greens), athletic fields, parks, cemeteries, commercial and residential lawns, and sod farms. Consult the label for turfgrass species restrictions.

U. MSMA — 2–4 lb a.i.
(MSMA 6 Plus) — 2.67–5.33 pt — 12 — Until dry
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 17
COMMENTS: Use allowed on golf courses and sod farms only. Golf courses: only one broadcast application allowed on newly constructed courses; on existing courses use is limited to spot treatment (100 sq ft per spot), not to exceed 25% of the total course in one year. Sod farms: two broadcast applications allowed per crop; a 25 foot buffer strip required for fields bordering permanent water bodies. A selective, translocated herbicide used principally for crabgrass, dallisgrass, nutsedge, and green kyllinga control. Also effective on a few broadleaf weeds. Apply when temperatures are warm (80 to 90ºF), but do not apply when temperatures are hot (greater than 90°F or turn injury could result. Temperature and turf type determine degree of selectivity. Make no more than two applications per season at a 30-day interval. Apply uniformly over area regardless of distribution of the weed. Hesitating with sprayer over weedier spots may cause excessive rate and injure or kill the turf. Use lower rates on more sensitive turfgrasses. Repeated applications of high rates reduces kikuyugrass. Turfgrass may be temporarily discolored. Bermudagrass, bluegrass, and zoysiagrass are most tolerant. Bentgrasses and fescues are moderately tolerant. Do not apply to St. Augustinegrass, red fescue, dichondra, or zoysiagrass.

V. PENOXSULAM — Label rates — 12 — Until dry
(Sapphire)
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
COMMENTS: A translocated, selective postemergence herbicide for control of annual and perennial broadleaf weeds in most cool- and warm-season turfgrasses. Effective on nutsedge, green kyllinga, oxalis, bittercress, and broadleaf plantain. Very effective in controlling English daisy; two applications (3 weeks apart) in late summer-early fall gives the best control of heavy infestations. Spring applications are also successful, but more applications may be needed. Do not use treated grass clippings for mulch. Do not allow herbicide to contact tree suckers or shallow roots. Labeled for use in golf courses, sports fields, residential and commercial lawns, parks, and sod farms. Golf course registration allows for selective removal of overseeded perennial ryegrass from bermudagrass during spring green-up.

W. PRONAMIDE — 0.75–1.5 lb a.i.
(Kerb 50WP) — 1.5–3 lb — 24 — Until dry
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 3
COMMENTS: A selective herbicide with pre- and early postemergence weed control on many grass weeds and chickweed. Used for control of annual bluegrass in bermudagrass turf only. Use 0.75 to 1 lb a.i. to control seedling to young tillering stages of annual bluegrass; a higher rate of 1 to 1.5 lb a.i. is needed for seed-forming stages. Do not apply where the herbicide can move into sensitive cool-season grasses. Do not overseed cool-season grasses within 90 days after treatment. It is also used to remove overseeded rye from warm-season grasses at 50% greenup. For use by licensed applicators only.

X. QUINCLORAC — 0.75 lb a.e.
(Drive XLR8) — 64 fl oz — 12 — Until dry
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 26
COMMENTS: A selective, translocated herbicide for control of many broadleaf and grass weeds; primarily used for control of clover and crabgrass (although some biotypes of smooth crabgrass may be resistant). Tips on mowing and adjuvants (methylated seed oil is recommended) are specified on the label. Also formulated and packaged with other broadleaf weed herbicides.

Y. QUINCLORAC/SULFENTRAZONE/2,4-D/DICAMBA — Label rates — 48 — Until dry
(Q4 Plus Turf Herbicide)
WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 26/14/4/4
COMMENTS: A combination of 4 active ingredients to make a versatile translocated, selective herbicide that will control many troublesome annual and perennial broadleaf and annual grassy weeds in established turfgrass. Controls clovers, composites, oxalis, plantains, spurge, thistles, wild carrot, garlic, and onion. Suppresses yellow nutsedge. Effective on crabgrass (although some biotypes of smooth crabgrass may be resistant). For use on residential and institutional lawns and in sod production. May cause temporary turfgrass yellowing. Adjuvants may result in additional injury. Temperatures above 90ºF increase the chance of turf injury. Safe in cool-season turf and fully dormant bermudagrass, zoysiagrass, and buffalograss. Not for use in bentgrasses, St. Augustinegrass, or dichondra. Not for use on greens, tees, or collars of golf courses. Not for use on lawns with desirable clovers or legumes.

	Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
Z.	SULFENTRAZONE (Dismiss CA)	Label rates	NA	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 14
COMMENTS: Provides pre and post-emergent control of many winter and summer annual broadleaf and grass weeds. Will suppress many sedges, including green kyllinga, and yellow and purple nutsedge. Safe for use in most turfgrass species. Can only be applied by licensed or certified applicator. Labeled for use in golf courses (fairways and roughs), athletic fields, commercial and residential lawns, and sod farms. Spray at 25 psi or less. Follow label directions for sprayer cleanout. Do not use with a surfactant or turf injury may occur. Preemergence activity is activated with 0.5 inch of water within 7 days after application and prior to weed germination.

AA.	SULFOSULFURON (Certainty)	Label rates	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
COMMENTS: A preemergence and postemergence translocated herbicide. Controls many annual and perennial sedges, cool-season grasses (*Poa annua, Poa trivialis*, tall fescue) and broadleaf weeds growing in established, warm-season, perennial grasses including bermudagrass, St. Augustinegrass and zoysiagrass, centipede, and kikuyugrass. Can also be used to control *Poa trivialis* (roughstalk bluegrass) in creeping bentgrass. Used to remove tall fescue and sedges from warm-season turfgrasses and Kentucky bluegrass.

BB.	TRICLOPYR (Turflon Ester)	0.5–1 lb a.e. 0.5–1 qt	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4
COMMENTS: A translocated herbicide used to control several broadleaf weeds; it is especially effective on creeping woodsorrel (oxalis) and clovers. Do not use on bentgrass or warm-season turf species such as common and hybrid bermudagrasses and kikuyugrass. Sometimes used in tall fescue lawns to suppress bermudagrass. Has some soil activity, so do not apply high rates or make repeated applications over the root zones of shrubs and trees. Apply in 50 to 100 gal water/acre to vigorously growing broadleaf weeds, preferably in spring or fall. May be retreated 4weeks following the first application for hard-to-kill weeds. To broaden weed spectrum and control dandelion, use a tank mix of amine or low volatile ester of 2,4-D with triclopyr. Do not apply mixture around trees or shrubs, because injury may result. Do not follow application with an irrigation within 4 hrs.

CC.	TRICLOPYR/CLOPYRALID (Confront)	Label rates	48	Until dry

WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 4/4
COMMENTS: A combination of two herbicides for control of a broad spectrum of annual and perennial broadleaf weeds in established cool- and warm-season turfgrass with well-anchored root systems. Usage restricted to golf courses only. Do not send clippings to a compost facility or use clippings for mulch or composting. Weeds in the legume family are very sensitive to low label rates, whereas weeds in the sunflower family will require the higher label rates. May injure stoloniferous grasses (bermudagrass and zoysiagrass) especially if the grass is stressed. Do not use on St. Augustinegrass or bentgrass. Do not reapply within 4 weeks and withhold irrigation for at least 6 hours after application. Clopyralid is susceptible to leaching through soil, so avoid potential groundwater contamination in sensitive sites.

DD.	TRIFLOXYSULFURON (Monument)	Label rates	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 2
COMMENTS: A selective, translocated herbicide used to control annual sedges, yellow and purple nutsedge, green kyllinga, oxalis, and spurge. Also suppresses crabgrass and dallisgrass. Harmful to cool-season turfgrass species; used to remove tall fescue, annual and perennial rye, and annual bluegrass (*Poa annua*) and roughstalk bluegrass (*Poa trivialis*) from bermudagrass, St. Augustinegrass, and zoysiagrass. It can only be used on golf courses, sod farms, and other non-residential turf, such as cemeteries and commercial building sites.

EE.	2,4-D LOW-VOLATILE ESTERS* (Weedone LV4)	0.48–0.95 lb a.i. 1–2 pt	12	Until dry

WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4
COMMENTS: A selective herbicide used for annual and perennial broadleaf weed control. Applied in spring when weeds are rapidly growing. Additional treatments may be required for late emerging weeds or on perennials. Available as an amine or ester formulation. The 2,4-D ester form is used for hard-to-kill perennial broadleaf weeds. Do not use it on newly-seeded turf, St. Augustinegrass, bentgrasses or dichondra. 2,4-D is often mixed with several other broadleaf weed killers (MCPP, MCPA, dicamba, clopyralid, carfentrazone, MSMA, triclopyr, quinclorac, etc.) to increase the spectrum of susceptible weeds or provide safety to turfgrass species or sites, or both. Apply in 100 gal water/acre. Use to control common yarrow, speedwells, mallows, mature knotweed. For spot treatments, use 4 tsp formulation per 1 gal water.

Common name (Example trade name)	Amount per acre	Ag Use REI‡ (hours)	NonAg Use REI‡ (hours)
FF. 2,4-D WATER-SOLUBLE AMINES* (Weedar 64)	1–1.5 lb a.i. 2–3 pt	48	Until dry
WSSA MODE-OF-ACTION GROUP NUMBER[1]: 4 COMMENTS: A selective herbicide used for annual and perennial broadleaf weed control. Applied in spring when weeds are rapidly growing. Additional treatments may be required for late emerging weeds or on perennials. Available as an amine or ester formulation. The amine formulation is generally more selective on turfgrass and is less subject to drift problems to nontarget species. For control of dandelion, plantain, and young pigweed, use 1 lb acid equivalent plus 1 qt surfactant in 100 gal water/acre. For spot treatment, use 2 tsp formulation plus 2 tsp surfactant to 1 gal water. For control of young knotweed (2- to 4-leaf stage), field bindweed, prickly lettuce, and filaree, use 1.9 lb acid equivalent plus 1 qt surfactant in 100 gal water/acre. For spot treatment, use 4 tsp formulation plus 2 tsp surfactant to 1 gal water. On bentgrasses use water-soluble amine only and do not exceed 0.75 lb acid equivalent/acre.			
GG. 2,4-D*/MCPP/DICAMBA* (Trimec, Triplet, etc.)	Label rates	48	Until dry
WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 4/4/4 COMMENTS: For broad-spectrum control of broadleaf weeds. Many formulations available for different turfgrass species. Use lower rates for bentgrass, hybrid bermudagrass and other sensitive turfgrasses. Nonselective on dichondra. Avoid applying to drought- and heat-stressed turf. Do not irrigate within 24 hrs of application. Newly seeded turf should not be treated until after the second or third mowing. Bentgrass is the most sensitive of the turfgrasses. Read label for further application directions. Do not allow spray drift to contact broadleaf ornamentals or injury may occur.			
HH. 2,4-D*/MCPP/DICAMBA*/CARFENTRAZONE (Speedzone, Speedzone Southern)	Label rates	48	Until dry
WSSA MODE-OF-ACTION GROUP NUMBERS[1]: 4/4/4/14 COMMENTS: Fast acting broadleaf weed killer. Speedzone Southern specially formulated for warm-season turfgrass.			

* Permit required from county agricultural commissioner for purchase or use.

1 Group numbers are assigned by the Weed Science Society of America (WSSA) according to different modes of action. Although weeds may exhibit multiple resistance across many groups, mode-of-action numbers are useful in planning mixtures or rotations of herbicides with different modes of action. For more information, see http://hracglobal.com.

‡ Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing. Agricultural use applies to sod farms and commercial seed production.

— Indicates use is not listed on label.

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Precautions for Using Pesticides

Pesticides are poisonous and must be used with caution. READ THE LABEL BEFORE OPENING A PESTICIDE CONTAINER. Follow all label precautions and directions, including requirements for protective equipment. Apply pesticides only on the crops or in the situations listed on the label. Apply pesticides at the rates specified on the label or at lower rates if suggested in this publication. In California, all agricultural uses of pesticides must be reported. Contact your county agricultural commissioner for further details. Laws, regulations, and information concerning pesticides change frequently. This publication reflects legal restrictions current on the date next to each pest's name.

Legal Responsibility

The user is legally responsible for any damage due to misuse of pesticides. Responsibility extends to effects caused by drift, runoff, or residues.

Transportation

Do not ship or carry pesticides together with food or feed in a way that allows contamination of the edible items. Never transport pesticides in a closed passenger vehicle or in a closed cab.

Storage

Keep pesticides in original containers until used. Store them in a locked cabinet, building, or fenced area where they are not accessible to children, unauthorized persons, pets, or livestock. DO NOT store pesticides with foods, feed, fertilizers, or other materials that may become contaminated by the pesticides.

Container Disposal

Dispose of empty containers carefully. Never reuse them. Make sure empty containers are not accessible to children or animals. Never dispose of containers where they may contaminate water supplies or natural waterways. Consult your county agricultural commissioner for correct procedures for handling and disposal of large quantities of empty containers.

Protection of Nonpest Animals and Plants

Many pesticides are toxic to useful or desirable animals, including honey bees, natural enemies, fish, domestic animals, and birds. Crops and other plants may also be damaged by misapplied pesticides. Take precautions to protect nonpest species from direct exposure to pesticides and from contamination due to drift, runoff, or residues. Certain rodenticides may pose a special hazard to animals that eat poisoned rodents.

Posting Treated Fields

For some materials, *restricted entry intervals* are established to protect field workers. Keep workers out of the field for the required time after application and, when required by regulations, post the treated areas with signs indicating the safe re-entry date. Check with your county agricultural commissioner for latest restricted entry interval.

Preharvest Intervals

Some materials or rates cannot be used in certain crops within a specified time before harvest. Follow pesticide label instructions and allow the required time between application and harvest.

Permit Requirements

Many pesticides require a permit from the county agricultural commissioner before possession or use. When such materials are recommended, they are marked with an asterisk (*) in the treatment tables or chemical sections of this publication.

Maximum residue levels

Before applying pesticides to crops destined for export, check maximum residue levels (MRLs) of importing country at http://mrldatabase.com.

Processed Crops

Some processors will not accept a crop treated with certain chemicals. If your crop is going to a processor, be sure to check with the processor before applying a pesticide.

Crop Injury

Certain chemicals may cause injury to crops (phytotoxicity) under certain conditions. Always consult the label for limitations. Before applying any pesticide, take into account the stage of plant development, the soil type and condition, the temperature, moisture, and wind. Injury may also result from the use of incompatible materials.

Personal Safety

Follow label directions carefully. Avoid splashing, spilling, leaks, spray drift, and contamination of clothing. NEVER eat, smoke, drink, or chew while using pesticides. Provide for emergency medical care IN ADVANCE as required by regulation.