ENY-351

UF UNIVERSITY of FLORIDA
IFAS Extension

Insect Pest Management on Golf Courses[1]

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Golf is an important recreational activity for many Florida residents and tourists. There are over 1400 golf facilities in Florida to choose from, ranging from private resorts to public driving ranges. Turfgrass managers and golfers alike value such qualities as a uniform playing surface and a nice green color in “good” turfgrass. Both of these qualities can be impaired by insects that feed on grass leaves, sap, or roots.

Several insects and mites feed on or live in grass, but not all of them cause economic or aesthetic damage. Many are harmless, some are beneficial, and some are pests. Only a few cause significant damage and need immediate control. Insects are only one of many potential causes for thin or brown grass. Diseases, nematodes, drought, and nutritional disorders can also be damaging. Correct identification of the problem can save money and prevent unnecessary pesticide applications.

The biology and management of the most important insect pests on golf courses in Florida are described in this publication. Pesticides labeled for insect control in turfgrass are listed in Table 1. Information regarding formulations is described in Table 2. In general, healthy turf is less vulnerable to pests and can recover faster from an infestation. Avoid overusing soluble nitrogen fertilizers, mow at the correct height for the grass species, reduce thatch, and avoid over-watering. Check every 7 to 10 days for pest activity, especially in "hot spots" where damage tends to reoccur.

Armyworms

The fall armyworm, *Spodoptera frugiperda* (Figure 1), is the most common species in Florida. Caterpillars first skeletonize the grass blades and later create bare spots.

The caterpillar is greenish when small, dark brown when mature, and can reach up to 1 1/2 inches in length. It has a light midstripe on its back with darker bands on either side. The midstripe ends in an inverted "Y" on the head. Pupation occurs in the soil. Adult moths are brown with a wing span up to 1 1/2 inches. Eggs are laid on leaf blades or almost any object near lawns. They are laid in clusters covered

1. This document is ENY-351 (IN410), one of a series of the Entomology and Nematology Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Publicaion date: January 2002. Revised: June 2009. Please visit the EDIS Website at **http://edis.ifas.ufl.edu**.

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Figure 1. Fall armyworm. Credits: J.L. Castner

with grayish, fuzzy scales from the body of the female moth.

Despite its name, the fall armyworm can damage turfgrass in the spring. They overwinter as pupae in the Gulf Coast region of the United States, and the moths migrate northward each spring, reaching the northern states in the fall (thus their name). Larval feeding occurs uniformly over a larger area, rather in patches. Larvae feed any time during the day or night, but are most active early in the morning or late in the evening.

Monitor by mixing 1 TBSP of liquid dishwashing soap in 1 gallon of water; pour the solution onto 4 square feet near the damage. Insects will crawl to the surface if present. Examine several suspected areas. Adults fly to lights at night.

Bermudagrass Mite

The bermudagrass mite, *Eriophyes cynodoniensis* (Figure 2), is tiny (about 1/130 inch long), and just visible with a 15- to 20-power hand lens. It is creamy white in color, somewhat wormlike in shape, and has 2 pairs of legs.

Figure 2. Bermudagrass mite. Credits: J.L. Castner

Bermudagrass is the only host for this mite species. The cultivars FloraTex, Midiron and Tifdwarf are considered resistant, but Tifway and other varieties are susceptible to the mite. The leaf tips of infested grass yellow slightly and internodes and leaves are shortened. The mite causes a characteristic type of damage: the grass blades turn light green and curl abnormally. The internodes shorten, tissues swell, and the grass becomes tufted (called “witches brooming”) so that small clumps are noticed. Large areas of grass may die and become infested with weeds. Damage is worse during hot, dry weather and when the grass is stressed.

One generation develops in 5 to 10 days. The eggs are deposited under the leaf sheath and after hatching, the mites molt twice before reaching adulthood. All life stages (eggs, nymphs, adults) live under the leaf sheath. Mites may disperse on the wind, other insects, or grass clippings. Infestations usually develop in the taller grass (rough areas, around sand traps, along canals, fence rows, etc.), so mow as close as practical (i.e., scalp the infested turf), collect and destroy grass clippings from infested areas.

Cutworms

Several species of cutworms (e.g., black or granulate cutworms) (Figure 3) occur in Florida, but seldom are serious pests in turfgrass.

Figure 3. Granulate cutworm.

Larvae usually dig a burrow in the ground or thatch (or use an aeration hole) and emerge at night to chew off grass blades and shoots. This damage may appear as circular spots of dead grass or depressed spots that look like ball marks on golf greens.

Larvae are mostly hairless, have 3 pairs of true legs and 5 pairs of fleshy prolegs on the abdomen. Most cutworms curl up when disturbed. Moths are

dull-colored with wing spans up to 1 1/2 inches. Eggs are laid randomly on leaf blades, and hatch within 10 days. Three to seven generations may occur each year.

Monitor using a soap flush, as described for armyworms.

Fire Ants

Imported fire ants, *Solenopsis* spp., are small, aggressive ants that build rounded nests or mounds that can be as large as 2 or 3 feet across. However, in sandy soil the mound does not maintain its shape. Imported fire ants occur throughout Florida, infesting over 30 million acres. Their mounds can damage mowing, harvesting, or electrical equipment.

Figure 4. Imported Fire Ant. Credits: J.L. Castner

Imported fire ants are 1/8 to 1/4 inch long and are reddish-brown to black. They are social insects, and can have single queen (having up to 240,000 individuals per colony) or multiple queen colonies (having up to 500,000 individuals per colony). Colonies have at least one queen ant, winged males and females (virgin queens), workers, and brood (eggs, larvae and pupae). In heavily infested areas, single queen colonies may have 40-150 nests per acre, and multiple queen colonies may have 200-800 nests per acre.

There are two species of imported fire ants. The black imported fire ant, *Solenopsis richteri*, was imported to the United States in 1918 or earlier. This ant now occupies only small areas in northern Alabama, northern Mississippi, Tennessee, Oklahoma and Texas. The red imported fire ant, *Solenopsis invicta* (Figure 4), was inadvertently introduced in the early 1930s and since that time has spread widely. This aggressive ant presently infests more than 340 million acres in Alabama, Arkansas, California, Florida, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Tennessee, Oklahoma, and Texas. The red imported fire ant creates large mounds in turfgrass and inflicts painful bites and stings to people, pets, livestock, and wildlife.

For more information, see Imported Fire Ants on Lawns and Turf (ENY-226) (http://edis.ifas.ufl.edu/LH059).

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Greenbug Aphids

The greenbug is a major pest of small grains, and also infests Kentucky bluegrass and seashore paspalum. These aphids prefer less frequently mowed areas around buildings or in landscapes near golf courses that have seashore paspalum. Damage initially may be misdiagnosed for irrigation or fertilization problems.

Greenbugs have piercing-sucking mouthparts, and as they suck on plant fluids, salivary enzymes are injected into the plant tissues and break down cell walls and chloroplasts. Feeding damage begins as a small yellow spot surrounded by a ring of watersoaked tissue. The spots enlarge, become brighter yellow, and merge with other feeding spots within several days. Feeding near leaf tips causes browning and necrosis of the tip, bordered below by yellow bands. Infested areas of turf become thinner. Honeydew and sooty mold are not usually obvious on infested plants.

Greenbugs are less than 1/16 inch long, oval-shaped, pale green aphids (Figure 5). Last instar nymphs and adults have a darker green stripe along the middle of the top of their abdomens. Their cornicles (the two “tail pipes” on the tip of the abdomen) are a darker or dusky color.

Greenbugs complete their life cycle in 7 to 9 days at 60 to 80°F. They reproduce asexually in Florida. Females produce 1 to 5 live nymphs per day when

Figure 5. Greenbug aphids. Credits: L. Buss, University of Florida

feeding on seashore paspalum. Winged aphids occur when crowding and damage symptoms increase.

Greenbugs prefer feeding on the top leaf surface, but finding the infestation is challenging because the aphids color blends in well, they are small insects, and the leaves tend to fold. In severe cases, 30 or more aphids can be on each grass blade, and several thousand per square foot of turf may exist. Examine off-color turfgrass for the presence of greenbugs using a 10X hand lens or run an insect sweep net through the suspect area. The insects will not be present on dead grass.

Keeping turf healthy and adequately irrigated will help it tolerate an infestation of greenbugs. Natural enemies, such as ladybird beetles, lacewings, bigeyed bugs, ground beetles, and spiders, may be able to help suppress a greenbug population.

Greenbug infestations are often in small patches, so spot treatments with insecticides may be possible. This means treating the entire infested area plus a 6-foot band around the infestation. A variety of contact (pyrethroid, organophosphate, carbamate) and systemic (neonicotinoid) insecticides are able to manage greenbug populations. Liquid treatments may be more effective than granular products because the granulars may drop too far away from the grass blades. Avoid mowing or irrigating for 24-48 hours after application. This pest has had a history of developing resistance to different insecticides, like organophosphates, so rotation of different modes of action is highly recommended.

Ground Pearls

Ground pearls, *Margarodes* spp. and *Eumargarodes* sp. (Figure 6), are related to mealybugs that attack the roots of bermudagrass, St. Augustinegrass, and zoysiagrass, but prefer centipedegrass. They occur throughout Florida, Georgia, Alabama, and up the east coast into North Carolina.

Figure 6. Ground pearls. Credits: J. Castner, University of Florida

Ground pearls suck juices from plant roots, which makes irregular patches of grass look unhealthy. Grass yellows, browns, and dies, especially in hot, dry weather. Weeds tend to invade infested areas.

Clusters of pinkish-white eggs, covered in a white waxy sac, are laid in the soil from March to June. Tiny crawlers attach to roots and enclose themselves with a hard, yellowish to gray-brown, globular shell. These "pearls" (also called cysts) range in size from a grain of sand to about 1/16 inch. They may occur as deep as 10 inches in the soil. The adult female is wingless, 1/16 inch long, pink in color, with well developed forelegs and claws. Adult males are rare, tiny, gnat-like insects. One generation may last from 1 to 2 years.

No management strategies, including insecticides, are currently available for ground pearls. Minimize plant stress and maintain proper fertility and soil moisture to help grass tolerate the damage.

Hunting Billbug

The hunting billbug, *Sphenophorus venatus vestitus* (Figure 7), is an under-recognized pest and its damage is often misdiagnosed. Zoysia and bermudagrass are preferred hosts, but Bahia, St. Augustine and centipede grasses are also attacked.

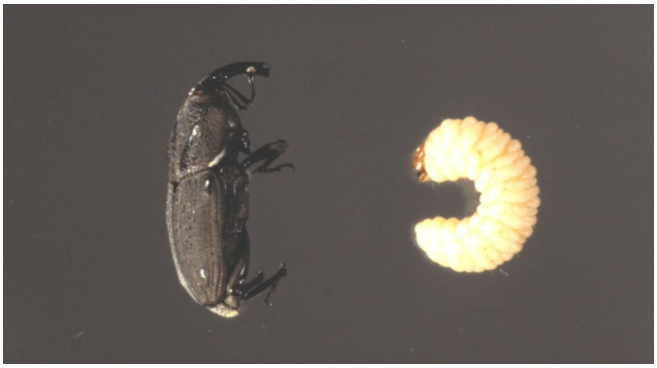

Figure 7. Hunting billbug adult and larva. Credits: J. Castner

Adult beetles are about 3/8 inch long and typically weevil-like in appearance with a short, fairly broad, recurved snout. They are gray to black but are often coated with soil. Several billbug species occur in Florida, but they can be distinguished by the pattern on their pronotum. Hunting billbug has a Y-shaped marking, with a parenthesis-shape on either side. The larvae are 3/8 inch long when mature and are legless. The body is white with a tan head capsule.

Adult billbugs chew small holes in the grass stems near the crown and deposit eggs in some of them. Larvae hatch in 8 to 10 days and feed inside the grass stem and crown area. Eventually, larvae go into the soil and feed on the roots. Because larvae do not move far, small, irregular areas of dead grass develop that resemble dollar spot disease. The larvae occur 1 to 3 inches deep in the soil among roots and runners. Pupation occurs in the soil. One generation develops in eight to 10 weeks, but all life stages are present year-round throughout the state. Injury is more pronounced during extended dry weather than when ample rainfall or irrigation is available.

To determine if billbugs are causing the problem, inspect the root zone. A non-chemical control option is to overseed in the fall with an endophytic ryegrass. Adults do not feed or lay eggs in endophytic turfgrass, which quickly reduces the infestation.

Mole Crickets

Three exotic mole cricket species (tawny, southern, and short-winged; *Scapteriscus* spp.) are significant pests in Florida. The native northern mole cricket is rarely a pest. Bermudagrass, bahiagrass, and centipedegrass are often attacked.

Tawny (Figure 8) and shortwinged mole crickets are herbivorous and consume all parts of the grass plant. The southern mole cricket is a predator and scavenger. All three species tunnel through the surface layer of the soil, causing considerable damage to the grass roots. The tunneling also loosens the soil so that the grass is often uprooted and dries out.

Figure 8. Tawny mole cricket. Credits: E.A. Buss

The front legs are flattened and adapted for digging. Tawny and southern mole cricket adults grow to be 1 1/2 inches long, whereas the shortwinged mole cricket adults only reach 1 inch. The tawny mole cricket is a lighter, creamy brown color, and the southern is grayish to dark-brown and usually has four distinct light spots on its prothorax (the area immediately behind the head). The two species can also be distinguished by their dactyls (digging claws): the southern has a U-shaped space between them, while the tawny has a V-shaped space. The short-winged mole cricket also has a U-shaped dactyl spacing.

In north and central Florida, egg laying begins in March with a peak in May. Eggs hatch in 20 to 25 days, and emergence is essentially complete by late June. Nymphs feed and mature through the summer,

molting five to eight times, and adults begin to appear in the fall. Tawny mole crickets overwinter mostly as adults, southern mole crickets mostly as large nymphs. There is only one generation per year in north and central Florida.

The tawny mole crickets life cycle is similar in south Florida, although oviposition and egg-hatch occur a few weeks earlier than farther north. The southern mole cricket has two generations a year in south Florida; egg laying occurs in early spring and again in summer. Generations of shortwinged mole crickets are not discrete. Egg laying occurs year around, with a peak in late spring or summer and a lesser peak in winter. Most mole cricket tunneling occurs at night, with most activity a few hours after dusk and again just before dawn.

Monitor using a soap flush early in the day. Southern and tawny mole cricket adults are attracted to light, especially in the spring. Nematodes, especially *Steinernema scapterisci* (Nematacs®), are effective at reducing mole cricket populations.

Scales/Mealybugs

Three grass scales occur in Florida: the Rhodesgrass mealybug, *Antonina graminis*, the Bermudagrass scale, *Odonaspis ruthae*, and a white armored scale, *Duplachionaspis divergens*. These are not very common, but can occasionally cause damage.

The Rhodesgrass mealybug (Figure 9) body is round and dark brown, but is covered with a white, cottony secretion that appears like tufts of cotton on the grass. It prefers Rhodesgrass, Johnsongrass, bermudagrass, and St. Augustinegrass. They infest the crown, nodes or leaf axils, not the leaves. Females deposit 300-600 eggs in a cottony ovisac without mating (no males exist). The crawlers disperse and begin feeding under a leaf sheath at a node. A white waxy sac, roughly spherical, is secreted around them. After settling, the insects will not move again. Sooty mold may be present. Infested grass slowly loses vitality and later appears to be suffering from drought. Injury is most severe during extended hot, dry periods.

Figure 9. Rhodesgrass mealybug. Credits: E.A. Buss

The Bermudagrass scale (Figure 10) adult female is oval, white and approximately 1/15 inch in diameter. This scale prefers taller grass, such as in golf course roughs, especially if those areas are heavily thatched and shaded. They are also found around sand traps, along fence rows, and other such areas.

Figure 10. Bermudagrass scales. Credits: L. Buss

Life cycles of the Rhodesgrass mealybug and Bermudagrass scale range from 60 to 70 days, and there are five generations per year in north Florida and continuous generations from Orlando south.

In addition, a new white armored scale has become established and common in Florida. *Duplachionaspis divergens* (Figure 11) was first detected as a new continental record in Florida in 2002, and has been intercepted in Alabama and Texas. Adult females lay on average 130 eggs each, and may have nine generations per year. The potential economic impact of this pest is uncertain, but it has

been detected on several species of grasses (Poaceae), including *Miscanthus* spp., St. Augustinegrass, bahiagrass, and zoysiagrass.

Cultural control of these scale insects includes collecting and destroying grass clippings.

Figure 11. *Duplachionaspis divergens* on zoysiagrass.

Twolined Spittlebugs

The twolined spittlebug, *Propsapia bicincta* (Figure 12), is the most common leafhopper-like insect to damage turfgrasses, especially bermuda, St. Augustine, centipede, bahia, crab, Johnson, and orchard grasses. It also feeds on many crops, ornamentals (especially holly), and weeds. Spittlebugs are present throughout the entire state, but they are more abundant in north and northwest Florida.

Figure 12. Two-lined spittlebug. Credits: J.L. Castner

Nymphs and adults both suck plant juices through their straw-like mouthparts. Infested turf wilts, purple-colored streaks develop up some grass blades, sometimes the turf turns yellow and eventually brown, and the blades curl. Heavy infestations may kill, wither, or reduce the growth of turfgrasses.

Nymphs may be yellow, orange, or white, and are covered by a frothy mass of spittle. Adults are about 1/4 to 1/2 inch long, black with two reddish-orange lines across the wings. Eyes are dark red.

Eggs are laid at the base of the grass in the thatch, in hollow grass stems or behind the leaf sheaths. There are four nymphal instars, and usually two generations per year. The first generation develops in about two and a half months. Eggs laid by second generation adults overwinter, and depending upon temperature and precipitation, most hatch from late March to late April. The first generation adults are abundant in June. The adult population peaks again in early August to early September.

Most of the spittle masses are not visible, as they are usually located near the soil surface or in the thatch. Spittlebugs require high-humidity conditions for optimum development. Thatch contributes to these conditions. Follow approved practices regarding mowing, fertilizing and irrigating to reduce thatch buildup. If a thatch problem exists, dethatching or verticutting will reduce spittlebug problems.

Tropical Sod Webworm

Tropical sod webworm, *Herpetogramma phaeopteralis*, larvae (Figure 13) are gray-green, and have brown or black spots on each segment. Mature larvae can be about 3/4 to 1 inch in length. Larvae remain curled up in the soil during the day and feed at night. Newly hatched larvae skeletonize the grass blades, while older larvae chew on grass blades near the soil surface.

Damage begins in small patches of short-clipped grass, about 1 to 3 inches in diameter. The grass may look ragged, and irregularly-shaped, larger brown patches may form. Small, green frass can be seen on the ground.

Sod webworm adults are small, tan to gray moths with a wingspan of 3/4 to 1 inch. They do not cause damage. Moths hide in shrubs and other sheltered

Figure 13. Tropical sod webworm. Credits: D.J. Shetlar, Ohio State University

areas during the day, begin flying at dusk, and lay clusters of 6-15 eggs on grass at night. Eggs hatch about a week later. Larvae progress through seven or eight instars. They pupate on the soil surface and emerge as adult moths in seven days. The life cycle from egg to adult requires five to six weeks at 78°F and 12 weeks at 72°F.

This pest is most active from April through November, but may occur year-round in southern Florida. Three generations occur in northern Florida and four generations in southern Florida. Use a soap flush to monitor for damaging populations.

White Grubs

White grubs (larvae of scarab beetles) are sporadic problems of turfgrass in Florida. However, certain species can be very damaging in coastal regions. At least five common genera occur in Florida. The masked chafers, *Cyclocephala* spp., are most frequently encountered, and *Tomarus* spp. are the second most common. Populations of *Strategus antaeus* (the ox beetle), *Phyllophaga* spp. (May/June beetles), *Euphoria sepulcralis* (a day-flying flower beetle), and *Ataenius* spp. are less common.

Grubs feed on the roots of all turfgrass species. They occur at or just below the soil–thatch interface. Mild damage may make the turf look yellowish, which could be misdiagnosed as a nutrient deficiency or disease. Severe damage results in large areas of dead turf because of lack of roots. Damage can be masked if the turf is frequently irrigated, but if drought or another stress affects the infested turf, the grass will quickly die. Damage from mature grubs is most pronounced during late summer and early fall.

Larvae are fat-looking grubs which lie in C-shaped positions (Figure 14). They are whitish in color with dark areas at the rear, three pairs of legs, and a tan to reddish-brown head. The adults are scarab beetles.

Figure 14. White grub. Credits: L. Buss

Depending on the species, the larvae range from 3/8 to 2 inches long when mature, and rest in a C-shaped position. Development through one generation may take six months to a year in Florida. As an example, the southern masked chafer, *Cyclocephala lurida*, has two generations per year in central Florida. The eggs are laid in the soil usually during April or May, 1 to 2 inches below the surface. The grubs feed on the grass roots until mid- to late summer, and pupate in the soil in August and September. Adults emerge in September and October, mate, and lay eggs. The larvae then hatch, feed during the winter months, and pupate in early spring. *Tomarus* spp. have a one-year life cycle. *Phyllophaga* spp. have 1-2 generations each year, and tend to be pests in ornamental plant beds or on tree roots. Ataenius has at least two generations per year. Development times for some of these pests take longer farther north because the temperatures are cooler.

To monitor, watch for adult scarab beetles flying at night near lights. To monitor white grub populations, cut 2-3 inches deep in a 1 foot square area of damaged grass. Lay the grass back, check the quality of the roots, and look for grubs in the soil.

When turf is easily pulled from the soil with little evidence of roots snapping and some grubs are present, it is likely that the grubs are responsible. To be more sure that grubs are the problem, cut three sides of a 1-foot-square piece of sod about 2 inches deep at the edge of one of the off-color areas and lay the sod back. See if the grass roots are chewed off, and sift through the soil and thatch looking for grubs. Check several places in the turf.

Additional Information

For more information, please refer to these UF extension publications:

- Ants (ENY-203)
- Chiggers (ENY-212)
- Fleas (ENY-205)
- Pillbugs, Centipedes, Millipedes and Earwigs (ENY-221)
- Ticks (ENY-206)
- Insecticides Used in the Urban Environment: Mode of Action (ENY-282)
- Formulations Comparison Chart (ENY-418)
- Insecticide Application Concerns (ENY-417)
- Insecticide Safety (ENY-416)
- Insecticides Used in the Urban Environment: Mode of Action (ENY-282)

Table 1. Insecticides registered for use on turfgrass in Florida[1].

Insect	Chemical Name	Notes
Ants, Imported Fire	**Baits:** Abamectin Fenoxycarb Fipronil Hydramethylnon Indoxacarb Pyriproxifen Spinosad S-methoprene **Contact insecticides:** Acephate[2] Bifenthrin Carbaryl[4] Deltamethrin Fipronil Lambda-cyhalothrin Thiamethoxam	Scatter granules around the edge of the nest, not on top, for a mound treatment. Ants take the bait into the colony and feed the treated oils to each other, which results in colony death. Some baits work within 48 hours, some take a month.
Beetles (adults)	Acephate[2] Bifenthrin Carbaryl[4] Cyfluthrin Deltamethrin Lambda-cyhalothrin	Adult beetles in the soil are not usually targeted for control, unless they are on the soil surface or making mounds. Hatching larvae are more vulnerable to insecticides. Adult billbugs make small notches on grass stems. The hunting billbug is the primary species in bermudagrass and zoysiagrass in Florida. Adults are active at night, so apply treatments later in the day, if necessary.
Billbugs (larvae)	**Preventive:** Clothianidin Halofenozide Imidacloprid Thiamethoxam **Curative:** Chlorantraniliprole Bifenthrin Carbaryl[4] Lambda-cyhalothrin Thiamethoxam Trichlorfon	Billbug larvae are legless (white grubs have legs). They are present year-round in most bermudagrass and zoysiagrass varieties. Bermudagrass and zoysiagrass are preferred hosts, but resistant varieties do exist. Overseeding with endophytic ryegrass helps reduce populations.

Table 1. Insecticides registered for use on turfgrass in Florida[1].

Insect	Chemical Name	Notes
Caterpillars (armyworm, cutworm, grass loopers, tropical sod webworm)	Acephate[2] *B. t.* var. kurstaki Bifenthrin Carbaryl[4] Clothianidin Cyfluthrin Deltamethrin Diflubenzuron Halofenozide Indoxacarb Lambda-cyhalothrin Permethrin Spinosad Trichlorfon	Treat at the first sign of damage. Reduced-risk products like *B.t.,halofenozide*, and spinosad are more effective against younger caterpillars. Caterpillars tend to become a problem in newly established turf, or in early fall, especially if the turf was fertilized heavily in late summer. Most feed at night. Turf can usually recover from caterpillar damage.
Greenbug Aphids	Acephate[2] Azadirachtin Bifenthrin Carbaryl[4] Clothianidin Cyfluthrin Deltamethrin Dinotefuran Imidacloprid Lambda-cyhalothrin Permethrin Thiamethoxam	This is a major pest of sugarcane and wheat, but has been found on seashore paspalum. Populations can build rapidly. It has a history of insecticide resistance, so resistance management is important. Spot treat up to 6 ft around the visible injury, when possible.
Ground Pearls	None available	Ground pearls are often found by the nematode assay lab when they look for nematodes in soil samples. Properly fertilize, irrigate, and mow at the correct height for the turf species, to keep the turf growing ahead of the damage.
Mites	Bifenthrin Deltamethrin Fluvalinate	Mow as low as possible, collect, and remove grass clippings to reduce the mite population. Using a wetting agent in the spray should improve coverage. Grass may outgrow damage if properly fertilized and irrigated. A repeat application may be necessary.

Table 1. Insecticides registered for use on turfgrass in Florida[1].

Insect	Chemical Name	Notes
Mole Crickets	Acephate[2] Bifenthrin Clothianidin Cyfluthrin Deltamethrin Fipronil Imidacloprid Indoxacarb Lambda-cyhalothrin Permethrin Thiamethoxam Trichlorfon **Baits:** Carbaryl[4] Chlorpyrifos[3] Indoxacarb **Beneficial nematodes:** *Steinernema scapterisci*	It is important to get insecticides into the soil, either by slit-injection, pre- or post-treatment irrigation (see product labels), or by using a wetting agent in the spray solution. Apply insecticides as late in the day as possible. Mole crickets are deeper in the soil during the day and closer to the soil surface at night. Use soap flushes to determine mole cricket age and density. Baits are most effective later in the summer, when older nymphs come onto the soil surface at night. Do not get baits wet. Beneficial nematodes attack large nymphs and adults, and do not damage plants. They are compatible with most insecticides, but not nematicides, to provide long-term mole cricket suppression.
Scales/Mealybugs	Bifenthrin Clothianidin Deltamethrin Imidacloprid Thiamethoxam	These insects are occasional turf pests, but they tend to be very damaging to groundcovers and ornamentals grasses. Cut infested leaf blades low and remove clippings to minimize infestations.
Spittlebugs, Twolined	Bifenthrin Carbaryl[4] Cyfluthrin Deltamethrin Lambda-cyhalothrin	Treat when most of the spittlebugs have become adults (June to September). Mow and irrigate before application to allow insects to penetrate the thatch. Spittlebugs cannot survive drought conditions. Avoid over-irrigation of turf to minimize infestation.
White Grubs	**Preventative:** Chlorantraniliprole Clothianidin Dinotefuran Halofenozide Imidacloprid Thiamethoxam **Curative:** Carbaryl[4] Trichlorfon **Nematodes:** *Heterorhabitis zealandica* *Steinernema glaseri*	Apply preventative treatments when adult scarab beetles are laying eggs or when eggs start to hatch (April to June in most of Florida, for most species).

Table 1. Insecticides registered for use on turfgrass in Florida[1].

Insect	Chemical Name	Notes
[1]Many others are available. No endorsement of products is intended, nor is criticism of unnamed products implied. ***Read container label carefully for use directions, application techniques, irrigation requirements, worker protection information, and precautions.*** **Be sure** the formulation of pesticide you use is labeled for use on turfgrass. [2]When using acephate, check pH of spray water and adjust to 5.5 - 6.0 when pH is above 7.0. Acephate is not registered for use on residential turf except as a fire ant mound treatment. Acephate will still be registered for broadcast application to turf on golf courses and sod farms. [3]Dursban not labeled for residential use. [4]Sevin (carbaryl) insecticide is going through re-registration with the EPA. Until this process is completed, all home lawn uses had to be removed from the labels of liquid Sevin products. Commercial lawn and ornamental uses are still labeled.		

Table 2.

IRAC Mode of Action Classification	Chemical Classes	Mode of Action	Active Ingredients / Chemical Names / Trade Name Examples1
1A	Carbamates	Acetylcholine esterase inhibitor	Carbaryl (Sevin)
1B	Organophosphates	Acetylcholine esterase inhibitor	Acephate (Orthene), chlorpyrifos (Dursban), diazinon, dimethoate (Cygon), malathion, trichlorfon (Dylox)
2A	Cyclodiene organochlorines	GABA-gated chloride channel antagonists	Chlordane, lindane
2B	Phenylpyrazoles	GABA-gated chloride channel antagonists	Fipronil (Chipco Choice, Chipco TopChoice, MaxForce FC, Over N Out)
3	DDT, pyrethroids, pyrethrins	Sodium channel modulators	Bifenthrin (Talstar, Wisdom), beta-cyfluthrin, cyfluthrin (Tempo), cypermethrin (Demon), deltamethrin (DeltaGard), cyhalothrin, lambda-cyhalothrin (Scimitar), esfenvalerate, fenpropathrin, fenvalerate, permethrin (Astro), resmethrin
4A	Neonicotinoids	Nicotinic acetylcholine receptor agonists / antagonists	Acetamiprid (TriStar), clothianidin (Arena), dinotefuran (Safari), imidacloprid (Merit), thiamethoxam (Meridian)
5	Spinosyns	Nicotinic acetylcholine receptor agonists (allosteric) - not group 4	Spinosad (Conserve)

Table 2.

IRAC Mode of Action Classification	Chemical Classes	Mode of Action	Active Ingredients / Chemical Names / Trade Name Examples1
6	Avermectins	Chloride channel activators	Abamectin (Ascend, Clinch, Varsity Fire Ant Bait)
7A	Juvenile hormone analogs	Juvenile hormone mimics	Hydroprene, kinoprene, methoprene (Extinguish)
7B	Fenoxycarb	Juvenile hormone mimics	Fenoxycarb (Award Fire Ant Bait)
7C	Pyriproxyfen	Juvenile hormone mimics	Pyriproxyfen (Distance Fire Ant Bait, Distance IGR, Esteem)
8A	Alkyl halides	Compounds of unknown or non-specific mode of action (fumigants)	Methyl bromide
11B2	*B. t.* subspecies *kurstaki*	Microbial disruptors of insect gut membranes	*Bacillus thuringiensis* subspecies *kurstaki* (Dipel)
15	Insect growth regulator	Inhibitor of chitin biosynthesis	Diflubenzuron (Dimilin)
18A	Diacylhydrazines	Ecdysone agonists / molting disruptors	Halofenozide (Mach 2), tebufenozide (Confirm)
18B	Azadirachtin	Ecdysone agonists / molting disruptors	Azadirachtin (Azatrol, Azatin)
20A	Hydramethylnon	Mitochondrial complex III electron transport inhibitors (Coupling site II)	Hydramethylnon (Amdro)
22	Oxadiazine	Voltage-dependent sodium channel blockers	Indoxacarb (Advion, Provaunt)
28	Anthranilic diamide	Acelepryn depletes calcium from insect muscles disrupting normal contraction	Chlorantraniliprole (Acelepryn, Calteryx)

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