Integrated Pest Management

TURFGRASS INSECTS

MU College of Agriculture, Food and Natural Resources

Published by University of Missouri Extension

IPM1020

This publication is part of a series of integrated pest management (IPM) manuals prepared by the IPM program of the University of Missouri. Topics covered in the series include an introduction to scouting, weed identification and management, plant diseases, and insects of field and horticultural crops. These IPM manuals are available from MU Extension at the following address:

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On the Cover

Hunting billbug, by Rick L. Brandenburg, North Carolina State University

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Brandenburg, Rick L. and Freeman, Callie P., eds. 2012. *Handbook of Turfgrass Insects*, 2nd ed. Annapolis, MD: Entomological Society of America.

Potter, Daniel A. 1998. *Destructive Turfgrass Insects: Biology, Diagnosis, and Control*. Chelsea, MI: Ann Arbor Press.

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Contents

Turfgrass Insects

Although insects are one of the most populous forms of animal life on earth, only a small number of them may, at some time, become a potential problem in turfgrass. Turfgrass insects can be somewhat cyclical and very dependent on a number of factors. Weather, suitable food sources, desirable habitat and predators all play a part in the population size of particular insect species.

Turfgrass damage is usually not observed until the numbers of an insect species reach a threshold level. For example, a homeowner does not need to treat a lawn with pesticides if only one or two white grubs are found while doing yardwork. However, if the homeowner peels back dead sod and finds more than five annual white grubs per square foot, treatment would be needed. Turfgrass-damaging insects may be present in a stand, but to warrant action, they need to be in a large enough population to cause decline.

Turfgrass pests cannot be controlled over long periods of time solely through the use of pesticides. To have healthy and vigorous turfgrass, it may be necessary to use pesticides in combination with sound cultural practices. A properly designed integrated pest management (IPM) system not only will maintain control of existing pests, but also will help prevent the recurrence of these pests and the possibility of new pest outbreaks.

Plan for potential pest problem before planting. Keep records of past problems at your site(s), and discuss pest problems with neighbors or colleagues.

A healthy, growing plant is the best defense against most insect pests. Many plants become more susceptible to pests if they are stressed. Following good turf management practices with mowing, proper watering, fertilization, aeration, thatch control and overall sanitation (e.g., removal of leaf litter or debris) produces good, healthy and dense turf.

Integrated pest management for insect control

Integrated pest management (IPM), the idea of integrating turf management cultural practices into a control program for turfgrass pests, is a concept that has been around for years. Efforts to start an IPM program begin with a discussion of basic plant health care.

More-detailed discussions about turfgrass species/cultivars, mowing, watering, fertility, aeration and thatch control are all part of this newer concept to put more emphasis on plant health care (PHC). Consider what can you do to develop the healthiest plant possible to combat or defend against weeds, diseases or insects.

IPM and PHC both still recognize the need for insecticides when all else fails. There are times when insect levels are just too great for even a healthy lawn to overcome. Turfgrass managers adopting IPM or PHC practices will have a better understanding of the environmental conditions that weeds, diseases and insects prefer.

When pest problems prevail, consider whether the turfgrass manager had done all that was culturally possible, and what changes might need to be made in the management program. Crucial decisions early in the development of a pest management program can make a significant difference in the direction a program takes.

Source: University of Arizona

Integrated pest managment is a systematic approach to solving pest problems through cultural practices, with insecticide application being a legitimate tactic when all else fails.

Turfgrass species and cultivars

If possible, select a species, cultivar or blend/mixture of turf that is best suited for the environmental conditions in which it will be grown. Turfgrasses adapted to Missouri's transitional climate are better able to withstand stress. Keep in mind, though, that no single turfgrass species will grow well here year-round.

However, several opportunities exist to select turfgrass species that offer insect resistance. Insects often prefer feeding on one turfgrass species over another, so selection of a species that is not a preferred food source for a prevalent insect pest will reduce potential for damage. Selection of endophyte-enhanced turfgrasses may also produce a healthy turfgrass stand with a reduced need for pesticide use. Endophytes are fungi (*Neotyphodium* spp.) that live within turfgrass plants. Endophyte-enhanced turfgrasses — perennial ryegrasses and tall fescues — resist insect damage by producing toxins called alkaloids. These alkaloids are not harmful to plants but deter insects that feed on them.

Mowing

Turfgrasses are placed under constant stress when they are mowed lower than their proper height. Scalping reduces plant vigor and reduces overall root growth, making the plant more susceptible to other environmental stresses and pests.

Keep turfgrasses mowed at the recommended height for the species, never remove more than one-third of the leaf blade at one time, and always keep mower blades sharp. Cool-season turfgrasses should be maintained at 3 inches or higher, whereas warm-season grasses may be maintained at 1 to 2 inches. Proper mowing practices will make a lawn more tolerant of insect damage.

Watering

Irrigation may be a vital part in the development of a healthy lawn; however, watering could have some drawbacks when insects are involved. Beetles of many root-feeding insects prefer moist soil to lay eggs. Egg-laying females seek out moist soils to lay eggs because the survival of their larvae, which are white grubs, is dependent on moisture.

Allowing turfgrasses to dry out slightly during the peak flight period, from late May to early June, may help to reduce the potential for white grub damage in late July to early August.

Good irrigation practices will help turfgrasses recuperate in late summer and early fall. Sound irrigation practices also encourage a vigorous root system and therefore healthier top-growth. Maintaining a healthy turf may help mask damage caused by insects such as billbugs or sod webworms.

When irrigating, avoid puddles and runoff. Most clay soils in Missouri have an infiltration rate of about ¼ inch per hour. Audit the output of your irrigation system by placing small cans at various spots in your lawn and measuring water depth

with a ruler after a certain amount of run time. Simply match the output of your irrigation system to the infiltration rate of your soil. Your irrigation system may only need to run 20 minutes to equal the infiltration rate of your soil type. Applying more water than the soil can absorb is a waste.

Fertility

Soil testing is the best start in developing a good fertility program. Avoiding excessive nitrogen applications will keep plants from becoming too succulent and therefore more susceptible to insect damage. Excessive fertilizer applications can also lead to significant thatch buildup, creating a good habitat for chinch bugs, billbugs and sod webworms. Follow local recommendations for a balanced fertility program to provide good shoot and root growth and recovery from light to moderate insect damage.

Aeration

Soil aeration can greatly improve the quality of turfgrasses. Aeration reduces soil compaction and allows air, water and nutrients to more readily enter the turfgrass root zone. Sustaining a quality root-zone environment increases the quality of shoots and leaf tissue several times over. When done at the proper times of the year, aeration will also make for more efficient use of irrigation and fertilizer applications.

The two most prevalent types of aeration are solid tine and hollow tine. Solid tine aerators simply punch into the soil profile. Hollow tine aerators physically remove plugs of soil, a process called core aeration. Soil removed by core aeration may be added into the thatch layer, thus increasing the population of soil microbes present to break down organic matter and thatch. Thatch reduction will discourage some insects from inhabiting the turfgrass stand.

Thatch

Thatch is the layer of partly decayed plant material (i.e., stems and roots) and organic matter between the growing turf and the soil. Excessive thatch acts as a sponge for water and nutrients, making them unavailable to the plant. Thatch also acts as a perfect habitat for insects to lay eggs, develop and populate a turfgrass stand.

Thatch can be controlled in several ways:

- Core aeration physically removes thatch and brings soil microbes to the surface to break down organic matter.
- Light top-dressings with topsoil similarly may result in thatch reduction by incorporating thatch-degrading soil microbes and providing them habitat.
- An active earthworm population also provides some decomposition of organic matter and thatch.

Mechanical removal of the thatch layer can be done with a dethatching or vertical-slicing machine. These machines can be rented at a local hardware or equipment-rental store. Set the depth of the blades just low enough to catch the soil surface. With the blades at this depth, the thatch layer will be partially removed and soil will be incorporated into the remainder.

Good plant health care practices are the key to developing a vigorous turfgrass stand. A healthy lawn can withstand two to three times the normal insect threshold for economic damage and offer a quick recovery when damage does occur.

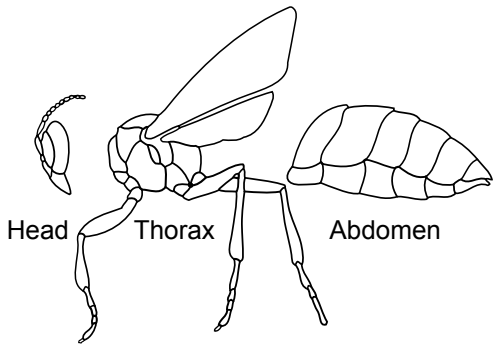
Cutworms feed on turfgrass crowns, resulting in thinned, tan-colored spots around tunnel entries. Birds on golf greens usually indicate the presence of cutworms.

Source: Lee Miller

Greenbug aphid damage on a tall fescue home lawn.

Insect anatomy

All adult insects have two physical characteristics in common. They have three pairs of jointed legs and three body regions: a head, thorax and abdomen.



Head

The head has antennae, eyes and mouthparts. Antennae vary in size and shape and can be helpful in identifying some pest insects. Antennae are movable and contain sensory receptors that are used to detect odors, tastes, vibrations and other stimuli. Insects have compound eyes composed of many facets, each with its own lens. Compound eyes enable insects to detect motion but probably do not produce clear images.

Most insects also have one to three simple eyes, or ocelli, located on the upper part of the forehead. These simple eyes do not see images, but they are sensitive to changes in light intensity that may trigger a reaction of flight or running.

The four general types of insect mouthparts are chewing, piercing-sucking, sponging and siphoning. Chewing mouthparts contain toothed jaws that bite and tear. Beetles, caterpillars (larvae of Lepidoptera, including armyworms, cutworms and sod webworm) and grasshoppers are in this group.

Piercing-sucking mouthparts consist of a long, slender tube that is forced into plant tissue to suck out juices or sap. Insects with these mouthparts include chinch bugs, greenbug aphids and spittlebugs. Mites, which are not insects, also have piercing-sucking mouthparts.

Sponging mouthparts are tubular tonguelike structures with a spongy tip to suck up liquids or soluble food. This type of mouthpart is found in house flies. Siphoning mouthparts are formed into a long tube for sucking nectar. Butterflies and moths have this type of mouthpart.

Thorax

The thorax contains the three pairs of legs and, if present, the wings. The various sizes, shapes and textures of wings help identify insect species. The forewings take many forms. In beetles, they are hard and shell-like; in grasshoppers, they are leathery.

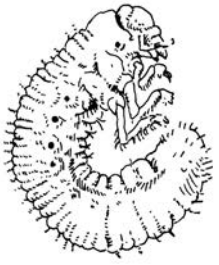
The forewings of flies are membranous; those of true bugs are part membranous and part hardened. Most insects have membranous hindwings. The wings of moths and butterflies are membranous but are covered with scales.

Abdomen

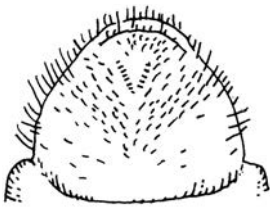
The abdomen is usually composed of 11 segments, but eight or fewer segments may be visible. Along each side of most of the segments are openings called spiracles, through which oxygen enters and carbon dioxide exits the internal respiratory system.

Near the end of the abdomen is an opening, the anus, through which waste passes from the insect's body. In some insects, the tip end of the abdomen has taillike appendages. It is on the abdomen of white grubs where raster, or hair, patterns identify one species of white grub from others.

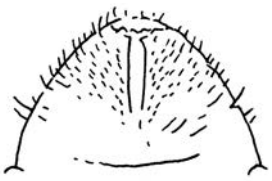
Rasters



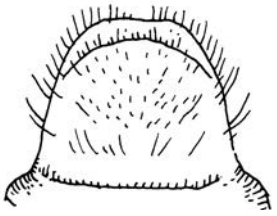
White grub raster location



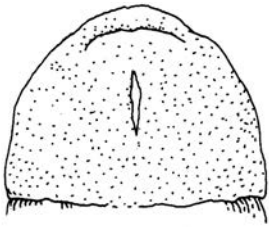
Japanese beetle raster



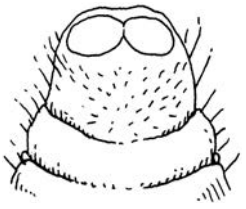
Typical May/June beetle raster



Typical masked chafer raster



Green June beetle raster



Black turfgrass ataenius raster

Five steps to effective pest management practices

1. Properly identify key pests and the damage they cause.
2. Monitor pest populations regularly.
3. Determine potential for economic loss from pest.
4. Select the proper pest control tactic, such as cultural, biological or chemical.
5. Evaluate the control measure used.

When using any insecticide, read and follow directions on the label accompanying that product. Reference to specific trade names in this publication does not imply endorsement by the University of Missouri; discrimination is not intended against similar products not mentioned.

Annual white grub species

White grubs are the primary insect problem many homeowners face annually. Damage is usually noticed in late July to early August. Damage from the first generation can occur in late May. Small or large patches of dead or dying grass will have pruned roots so that sod can be pulled up or rolled back like a loose carpet. Numerous C-shaped, whitish larvae with brown heads will lie in the upper soil directly below dead sod. Predators, such as skunks or raccoons, often dig voraciously for grubs and may cause additional damage.

Adults are scarab beetles, including billbugs, black turfgrass ataenius beetles, green June beetles, Japanese beetles, masked chafers and May/June beetles. Black turfgrass ataenius is not a common pest in home lawns. White grub species can be identified by the time of year when the grub is present; size of the grub; and raster patterns.

May/June beetles

Phyllophaga spp.

Important turfgrass species affected: All

Adult May/June beetles are shiny, reddish brown and nearly 1 inch long. Adults are more active and attracted to lights at night, frequently flying into windows and screen doors. This beetle species has a three-year life cycle, and the adults can be damaging to trees and ornamentals. Newly hatched larvae should be treated during late July to early August; however, in the second year treatments can be made from April through September as the grubs continue to feed. Grubs complete feeding the third year, overwinter as adults, and emerge the following spring to complete the life cycle.

Source: Steven Katovich, USDA Forest Service, Bugwood.org

Masked chafers

Cyclocephala spp.

Important turfgrass species affected: All

The masked chafers, of which there are several species, are often referred to as the annual white grub and may be the largest contributor to the annual white grub complex in Missouri. These beetles have a one-year life cycle. Adult beetles are tan, about ⅝ inch long and attracted to lights. Treatment should be made about four weeks after the adult beetles start to emerge, when eggs begin to hatch in late July to early August.

Source: Daniel Potter

Annual white grub species

Source: UGA, Bugwood.org

Black turfgrass ataenius

Ataenius spretulus

Important turfgrass species affected: Kentucky bluegrass, bentgrass, perennial ryegrass

Black turfgrass ataenius (BTA) is primarily a pest on golf courses and not home lawns. Early damage appears as a small wilted spot, with higher BTA grub infestations resulting in larger patches of wilting and thinning turf, similar to symptoms caused by other annual white grub species. Grubs are about ¼ inch long and feed on the roots. Two BTA generations occur per year in Missouri, in May and August. Preventive applications may be necessary in April or May when adult beetles are emerging from overwintering.

Source: UGA, Bugwood.org

Green June beetles

Cotinis nitida

Important turfgrass species affected: All

Grubs of the less common green June beetle are white and have the unusual habit of crawling on their backs. Damage is usually mechanical in nature, as these grubs simply push up mounds of dirt. The adult is a large, velvety green and tan beetle about 1 inch long. These beetles are attracted to soils with high organic matter, and grubs are commonly found in organic matter, which is their primary food source.

Source: Lee Jenkins Collection

Japanese beetles

Popillia japonica

Important turfgrass species affected: All

The Japanese beetle was introduced into Missouri in the early 1900s, with populations mainly centered in urban areas, but can now be found statewide. Adults beetles are metallic green or brown, with reddish-brown wing covers. As well as being a problem on ornamentals and row crops, these beetles contribute to the annual white grub complex. Grubs feed on turfgrass roots, causing a wilting appearance and gradual thinning.

Other subsurface-feeding insects

Billbugs

Sphenophorus parvulus
Sphenophorus venatus

Important turfgrass species affected: Zoysiagrass, bermudagrass, Kentucky bluegrass, perennial ryegrass

Source: Robert Sites

Billbug damage is one of the most commonly misdiagnosed turfgrass issues. It is often confused with drought, disease, chinch bug or white grub damage. Symptoms of billbug injury are spotty, dead patches of turf that are easily pulled up, with stems breaking off at the crown. In addition, stems are hollowed out and often filled with light brown frass. Adult billbugs overwinter and emerge in the spring to feed by chewing holes in grass stems. At this time, the adults also lay eggs in these cavities. Eggs hatch within the plant, and the larvae eat their way down through the plant and emerge through stolons or rhizomes into the thatch/root zone and continue feeding. Billbug grubs are small, only about ¼ inch long, and legless, unlike other annual white grubs. They can be found in June and July during periods of peak activity and damage. Depending on species, one or multiple generations may occur in a single season. The best time to control a known billbug infestation may be preventively in late April or early May to target the overwintering adults before egg laying begins.

Crane flies

Tipula spp.

Important turfgrass species affected: None currently in Missouri

Source: Lee Jenkins Collection

Several native crane fly species can be abundant and are generally nondamaging, making correct identification important before any intervention. Adult crane flies resemble and are often mistaken for large mosquitoes. They emerge in late August through September. Larvae overwinter, with feeding damage most evident in spring. A healthy turfgrass stand can support 40 to 60 crane fly larvae per square foot, so proper fertility, irrigation and mowing practices should be considered before population reduction.

Mole crickets

Scapteriscus spp.

Important turfgrass species affected: All

Source: Lee Jenkins Collection

Mole crickets damage plants by feeding and extensive tunneling. The winged cricket is brown to grayish-brown and has front feet that are spadelike for digging and burrowing beneath the soil surface to feed on turfgrass roots. Heavily infested turfgrass has virtually no root system. Mole crickets in different life stages behave differently, and knowledge of the timing of local population cycles is critical for designing management strategies for particular sites. Mole cricket mating and dispersal flights occur in the spring.

Surface-feeding insects

Source: Lee Miller

Armyworms (Fall)

Spodoptera frugiperda

Important turfgrass species affected: All

The fall armyworm is susceptible to extreme cold temperatures, and therefore doesn't overwinter in Missouri. Moths migrate into Missouri in late spring and lay eggs of first generation worms. Two to three generations occur during a season in Missouri, with most problems occurring in late summer and fall after several generations have increased the population. Armyworm larvae feed on all aboveground leaf tissue, and as the name implies, the population moves as an "army" across a turfgrass stand rapidly causing widespread bare areas. Damage is often associated with lush turfgrasses, so restricting summer nitrogen may help limit the problem. Because armyworm occurrences are sporadic, turfgrass stands should be carefully monitored so curative treatment can be applied if necessary.

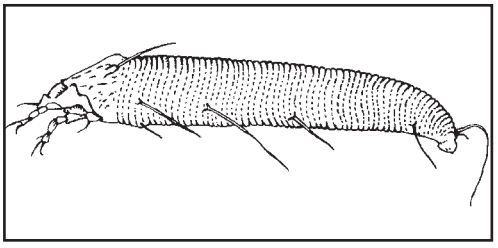


Illustration by Dennis Murphy

Bermudagrass mites

Eriophyes spp.

Important turfgrass species affected: Bermudagrass

This mite is a more serious problem of bermudagrass on golf courses, home lawns and commercial landscapes in southern states than it is in Missouri. The mites live and feed under the leaf sheaths. Infested bermudagrass will appear weak and off-color in the spring and does not respond to irrigation or fertilization. Leaf blades are often twisted and yellow at the tips. "Tufted" or "rosetted" growth results from shortened stem internodes. If not treated, the bermudagrass will thin and die out. Hot, dry weather will enhance the symptoms when the grass is under stress.

Source: Lee Miller

Chinch bugs

Blissus spp.

Important turfgrass species affected: Zoysiagrass

Chinch bug damage starts as small yellow or brown discolored areas, with individual leaves often having an orange tinge. Damage progresses rapidly as the population increases. Nymphs and adults are sap feeders at crowns and stems, and inject a toxin in their saliva that disrupts water and nutrient movement. Young nymphs are orange-brick red with a white band across their back, whereas adults are about 3⁄16 inch long and black with small wings. Adults overwinter in protected areas and emerge in May, with a second generation arriving in July or August. Chinch bug damage is normally most severe in full sun and along sidewalks and driveways. Generally, treatment is only necessary during the second summer generation, with best results achieved by treating the damaged area and at least 3 feet beyond, or the entire lawn.

Surface-feeding insects

Cutworms

Agrotis ipsilon (black)
Peridroma saucia (variegated)

Important turfgrass species affected: Creeping bentgrass

Cutworm caterpillars feed at night and cut grass blades off close to the ground in a circular pattern around their burrows. This feeding produces brown spots 1 to 2 inches in diameter. Variegated cutworms are occasional pests of lawns, but the black cutworm is a perennial problem on creeping bentgrass golf greens. Adult moths may migrate from southern states and lay eggs on the leaves and stems of plants, preferring lush, dense stands. One to four generations occur per season. Light cutworm infestations are often adequately controlled by predators (birds) and parasites. If necessary, insecticide treatments should be applied late in the day and allowed to dry on the leaf surface.

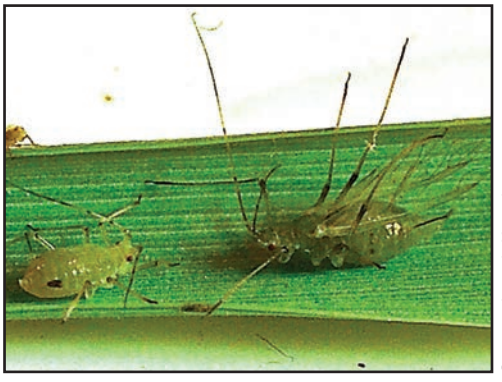
Source: CSSA

Greenbug aphids

Schizaphis graminum

Important turfgrass species affected: Tall fescue, Kentucky bluegrass, perennial ryegrass

Like chinch bugs, greenbug aphids feed on plant sap and inject a toxin in their saliva that results in plant collapse and death. Damage appears in brown, irregular patches with yellow to orange colored with margins. Damage normally occurs in mid to late spring in Missouri, as greenbug populations can rise rapidly and are not yet held in check by natural enemies such as lady beetles, parasitic wasps or lacewings. Routine scouting for the numerous small greenbugs on leaf blades should be conducted in the spring, and treatment should be made only when necessary.



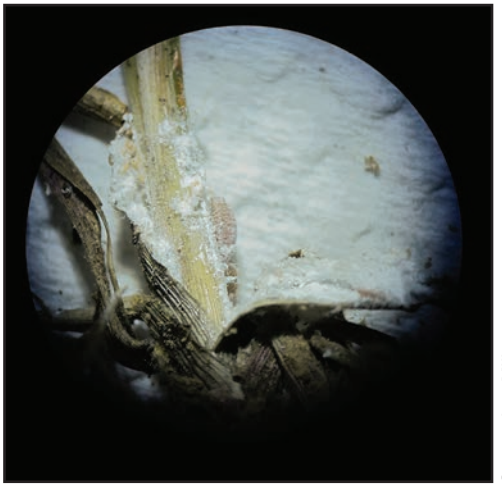
Source: Joseph Krauska

Mealybugs

Antonina graminis (rhodesgrass mealybug) and others

Important turfgrass species affected: Zoysiagrass, bermudagrass, others

Mealybugs are an occasional pest problem, mainly on zoysiagrass lawns in Missouri. Mealybugs feed by sucking plant sap from under the leaf sheath at the nodes or crown of the plant. Damage is often a general discoloration and wilting symptom often mistaken for drought. Mealybugs are covered in a white, waxy secretion that resembles fungal mycelium and often covers the leaf sheath and crown of the plant where feeding has occurred. Turfgrasses can often tolerate some mealybug feeding without injury until natural enemies can reduce the population, so selecting proper turfgrasses and alleviating stress may eliminate the need for treatment. If treatment is necessary, thorough coverage and tank-mixing a surfactant may aid control.



Source: Lee Miller

Surface-feeding insects

Source: CSSA

Sod webworms

Several genera in the family Crambidae

Important turfgrass species affected: Creeping bentgrass, Kentucky bluegrass, Tall fescue

Damage from sod webworms is first noticed as small irregular brown patches, with grass blades chewed of at or just above the soil surface. The adult is a buff-colored moth with a 1-inch wingspan that looks tubular when at rest because of the way the wings wrap around its body. Webworm larvae are about 1 inch long and gray, with brown spots on each body segment. Larvae often hide in silk-lined, pencil-sized tubes within the thatch layer, which is a sign of their activity. Two to three generations occur during a season, and damage can be expected during the late summer when populations are peaking. Except under drought conditions, most webworm damage occurs on high-amenity turfgrasses, such as golf greens, new sod fields or newly established lawns under high fertilization. Endophyte-enhanced turfgrasses, such as tall fescue, are toxic to webworm larvae and should be used where possible. If treatment is necessary, leave residue on leaves as long as possible.

Nuisance pests

Source: Lee Jenkins Collection

Ants

Various genera in the family Formicidae

Ants produce unsightly earthen mounds that can thin the surrounding turf. Excavating soil can damage roots. Most ant species occurring in turfgrass seldom cause serious damage.

Nuisance pests

Centipedes

Various genera in the class Chilopoda

Primarily, centipedes are nuisance pests that are found under boards or in mulches. Occasionally, they will invade buildings during dry weather. Chemical control for these pests is rarely necessary. Removing thatch from turf and keeping mulches away from buildings will help prevent centipedes from becoming a nuisance.

Source: Richard Houseman

Millipedes

Various genera in the class Diplopoda

Primarily, millipedes are nuisance pests that are found under boards or in mulches. Occasionally, they will invade buildings during dry weather. Chemical control for these pests is rarely necessary. Removing thatch from turf and keeping mulches away from buildings will help prevent millipedes from becoming a nuisance.

Source: Lee Jenkins Collection

Chiggers

***Trombicula* spp.**

Chigger mites can be found where vegetation is abundant. They can become a serious problem in relatively dry areas. Chigger mite larvae will cling to clothing or bare skin. They insert their mouthparts in a skin pore or hair follicle. After engorging themselves, the larvae will drop off. Their feeding can cause severe irritation and itching. Apply a recommended commercial repellent to your clothing and legs. A hot, soapy bath soon after exposure will help prevent or reduce the number of bites. Although a nuisance to humans in outdoor settings, chiggers do not damage turfgrass.

Source: Susan Ellis, Bugwood.org

Nuisance pests

Source: Bruce Barrett

Cicadas (periodical)

Various species in the genus Magicicada

Cicadas are large, robust sucking insects that are most noticed from the screechy mating call of the males on trees. Fortunately, these masses of cicadas usually occur only once every 13 or 17 years in a given area. Periodical cicadas have a fat, wedge-shaped, nearly black body with clear wings. Their eyes are red, and their legs and veins in their wings are orange. It is not practical to control the nymphs because they live 12 inches underground. Small trees can be sprayed or covered during the peak emergence period to prevent twig damage.

Source: Jessica Louque, Smithers Viscient, Bugwood.org

Cicada killers (digger wasps)

Sphecius speciosus

Small mounds of soil can be seen on top of turf coming from ¾-inch-diameter holes excavated by the adult cicada killer wasp. Thoroughly spray or dust around nest openings when treatment is required. The female wasp can inflict a painful sting.

Source: Lee Jenkins Collection

Crickets

Various genera in the suborder Ensifera

Crickets become numerous under boards, rocks and other damp hiding places around the lawn. They often invade buildings and are generally considered a harmless, noisy nuisance.

Nuisance pests

Earwigs

Various genera in the order Dermaptera

Earwigs are fast-moving, small insects that can become numerous. They forage during the night and burrow into the soil during the day. They are beetlelike insects about ¾ inch long with a pair of "forceps" on the abdomen. They do little or no damage to turfgrasses; however, they use piles of grass clippings as breeding sites.

Source: Lee Jenkins Collection

Fleas

Various genera in the order Siphonaptera:
***Ctenocephalides felis* (cat flea)**
***Pulex irritans* (oriental rat flea)**

During the warmer months, lawns can become heavily infested with fleas when infested pets rest or sleep on the lawn. Adult fleas will hop onto humans and suck blood, which causes irritation and itching. In lawns or outdoor pet quarters, the immature flea will feed on the excrement of rodents or pets and on decaying organic matter. Treat entire lawns and pet quarters. Use flea collars on pets.

Source: Joseph Berger, Bugwood.org

Grasshoppers

Various genera in the suborder Caelifera

Grasshopper populations can build to massive numbers following several seasons of dry weather; however, in most years, numbers are not at harmful levels. Grasshoppers feed on the tender parts of grass and other plants, but there are generally enough natural predators to keep this insect under control. Grasshoppers are a nuisance only in well-kempt turf, and actual injury is an extreme rarity.

Source: CSSA

Nuisance pests

Source: Charles Olsen, USDA APHIS, Bugwood.org

Leafhoppers

Various genera in the family Cicadellidae

Leafhopper adults and nymphs feed on juices with their piercing-sucking mouthparts. Heavily infested turf tends to become mottled or bleached, and it then dries out as if under drought stress. Leafhoppers rarely cause severe damage to healthy lawns. Clouds of leafhoppers in flight may be noticed ahead of mowers.

Source: Lee Jenkins Collection

Pillbugs and sowbugs

Various genera in the family Armadillidiidae
Various genera in the family Oniscidae

Pillbugs and sowbugs often become numerous under stone walks, boards and other damp hiding places around the lawn. Although they chew on roots of vegetation, they primarily feed on decaying organic matter. Even though the pillbug and sowbug are found almost everywhere, they are generally considered a harmless nuisance.

Source: David Stephens, Bugwood.org

Grass spiders

Various genera in the order Araneae

Spiders are generally considered beneficial; however, some can cause irritating bites. Spiders are evident when spider webs are noticed in the early morning dew. They do not cause any turf damage and are considered more of a nuisance.

Nuisance pests

Spittlebugs

***Prosapia bicincta* (twolined)**

Spittlebugs feed on clover, legumes and ornamentals, but they are rarely a problem in turf. When the spittlebug becomes plentiful in turf, the grass is generally competing with an unlimited supply of weeds and clover. The tiny, pink to yellow-green nymph is seldom seen but causes widespread damage. It attaches itself to vegetation and encloses its body in a mass of white foam or "spittle." It drains the fluid from the plant and remains hidden in the spittle until fully grown. Insecticide applications should be made in July with the second generation.

Source: Charles Bryson, USDA ARS, Bugwood.org

Ticks

Various genera in the order Parasitiformes:
Dermacentor
Ixodes

Ticks are leachlike parasitic pests that sometimes become more than a nuisance. Tick bites can cause itching, irritation and infection. The likelihood of infection is increased if the tick is removed incorrectly, which causes the mouthparts to remain in the wound. Ticks can transmit serious diseases to humans and pets. Ticks are seldom a problem in a well-maintained lawn, but they often infest edges bordered by tall weeds and brush. Treatments are most effective when applied along borders, brushy areas and footpaths that are routinely traveled.

Source: Jim Occi, Bugwood.org

Yellowjackets

***Vespula* spp.**

Yellowjackets are the most likely dangerous stinging insect in the United States. Their name is based on the distinctive black and yellow color pattern of their body. Nests are often located underground, and yellowjackets become extremely aggressive when their nests are disturbed. If the nest can be located, elimination of the colonies should be done only at night when most of the yellowjackets are in the nest and less active. Aerosols and dust formulations of pesticides usually work best.

Source: Jim Baker, NCSU, Bugwood.org

Using insecticides

Insecticide use should be the last resort in managing insect pests, but may be necessary even with a careful integrated pest management plan in place. Herbivorous and nuisance insects are mobile and tend to establish at their preferred food source, which may just happen to be lawns, golf courses or sports fields. Most turfgrass managers realize that maintaining acceptable appearance and turf health will involve the use of synthetic pesticides, and that proper stewardship involves careful, responsible and prudent application of these compounds.

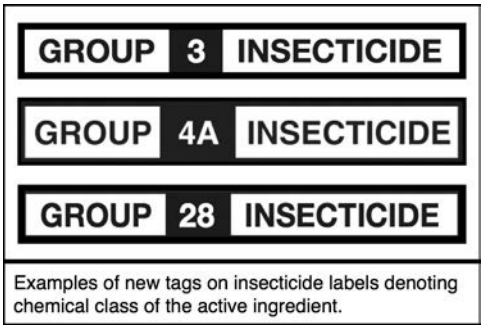
Safeguarding beneficial insects in the landscape, particularly bees and other pollinators, is a critical issue that must be considered before insecticide use. New bee advisory icons are now placed on the label of insecticide products that carry risk for affecting pollinators. When using turfgrass insecticides, several practical measures for protecting these nontarget insects should be implemented.

- Mow all areas before apply insecticides. Mowing will remove most of the weed flowers and reduce bee foraging in insecticide-treated areas.
- Avoid treating weedy areas, particularly those that contain flowering weeds.
- Remove weeds with an herbicide or by another method before insecticide treatment.
- Apply in early morning or late evening when bees are less likely to be actively foraging.
- Use buffer strips between treated areas and landscape beds.
- Wait until after spring petal fall of flowering trees and shrubs to treat.
- Consider alternative chemistries.

Insecticide resistance — the development of insect populations that can tolerate once lethal insecticide doses — is another major problem. Chinch bugs, billbugs, fall armyworms and Japanese beetles are examples of turfgrass insects that have had confirmed cases of insecticide resistance. Several management strategies should be incorporated to reduce the risk of resistance development.

1. Use proper cultural practices to maximize plant health and reduce or eliminate the need for pesticides.
2. On plants with a history of the pest problem, apply pesticides preventively based on the pest biology and before the plant expresses symptoms. This practice will allow treatment of smaller pest populations.
3. Consider the use of multisite pesticides first.
4. Limit the use of site-specific pesticides from the same class during a single season.
5. If a large pest outbreak occurs, use a multisite partner tank-mixed with a single-site pesticide.
6. Rotate site-specific pesticides so a constant selection pressure is not put on the pest population.

A crucial aspect of a resistance management strategy is to know not only the insect, but also the insecticide being used. Insecticides are grouped into chemical classes according to their biochemical mode of action on the pest. To effectively implement number 4 or 6 above, products from the same group should not be applied exclusively and should be rotated with insecticides from another class. Current insecticide labels include banners indicating the chemical class group, which should be used to facilitate resistance management.



Examples of new tags on insecticide labels denoting chemical class of the active ingredient.

Banners on insecticide labels indicate class or mode of action.

The following pages contain information describing active ingredients, products and target insects of insecticides currently labeled for turfgrass insect control. Insecticide labels are subject to change. These tables should be used only as a reference, with the current insecticide label serving as the authoritative guide for precautions and use requirements.

Insecticide tables

Table 1. Subsurface feeding insects: Labeled insecticides for use on turfgrasses.

Insecticides and IRAC* codes	Acephate[x]	Bifenthrin	Carbaryl[y]	Chlorpyrifos[x]	Chlorantraniliprole	Clothianidin	Clothianidin + bifenthrin	Cyantraniprole	Cyfluthrin	Deltamethrin	Dinotefuran	Fipronil	Halofenozide	Imidacloprid	Imidacloprid + bifenthrin	Indoxacarb	Lambda-cyhalothrin	Permethrin	Spinosad	Thiamethoxam	Thiamethoxam + lambda-cyhalothrin	Trichlorfon
	1B	3	1A	1B	28	4A	3 4A	28	3	3	4A	2B	18A	4A	3 4A	22	3	3	5	4A	3 4A	1B
Billbugs		◊	Δ	◊	o	o	o	o	◊	◊	◊		o	o	o		◊			o	o	o
Black turfgrass ataenius	o	◊	Δ	◊	o	o	o	Δ	◊	◊	o		o	o	o		◊		◊	o	◊	o
Crane flies		o	o	Δ	o	o	o	o			o			o	o	o				o		
Green June beetles			o	o	o	o	o	o			o		o	o	o		1			o	o	o
Japanese beetles			o	o	o	o	o	o		◊	o		o	o	o		1			o	o	o
Masked chafers			Δ	o	o	o	o	o			o		o	o	o		1			o	o	o
May/June beetles			o	o	o	o	o	o			o		o	o	o		1			o	o	o
Mole crickets	o	o		o		1	o		o	o	o	o		o	o	◊	o	o	o	1	o	o

* Insecticide Resistance Action Committee

[x] Not for use on residential lawns.

[y] Only spot treatments allowed on residential turf.

o denotes control

Δ denotes larvae control only

◊ denotes adult control only

1 denotes suppression

Table 2. Surface feeding insects: Labeled insecticides for use on turfgrasses.

Insecticides and IRAC* codes	Acephate[x]	Bifenthrin	Carbaryl[y]	Chlorpyrifos[x]	Chlorantraniliprole	Clothianidin	Clothianidin + bifenthrin	Cyantraniprole	Cyfluthrin	Cypermethrin	Deltamethrin	Dicofol[x]	Dinotefuran	Halofenozide	Imidacloprid	Imidacloprid + bifenthrin	Indoxacarb	Lambda-cyhalothrin	Permethrin	Spinosad	Thiamethoxam	Thiamethoxam + lambda-cyhalothrin	Trichlorfon
	1B	3	1A	1B	28	4A	3 4A	28	3	3	3	UC	4A	18A	4A	3 4A	22	3	3	5	4A	3 4A	1B
Armyworms (Fall)	O	O	O	O	O	O	O	O	O		O		O	O		O	O	O		O		O	O
Bermudagrass mites		O		O			O		O		1	O				O		O					
Chinch bugs	O	O	O	O	1	O	O	1	O				1		1	O			O		1	O	O
Cutworms	O	O	O	O	O	O	O	O	O		O		O	O	1	O	O	O		O		O	O
Greenbug aphids	O	O	O	O		O	O		O	O					O	O			O		O	O	
Mealybugs	O	O	O	O		O	O		O		O		O		O	O		O	O		O	O	
Sod webworm	O	O	O	O	O	O	O	O	O	O	O		O	O		O	O	O	O	O	O	O	O

* Insecticide Resistance Action Committee

[x] Not for use on residential lawns.

[y] Only spot treatments allowed on residential turf.

o denotes control

Δ denotes larvae control only

◊ denotes adult control only

1 denotes suppression

Table 3. Nuisance/occasional insect pests: Labeled insecticides for use on turfgrasses.

Insecticides and IRAC* codes	Acephate[x]	Bifenthrin	Carbaryl[y]	Chlorpyrifos[x]	Clothianidin	Clothianidin + bifenthrin	Cyfluthrin	Cypermethrin	Deltamethrin	Fipronil	Hydramethylnon	Imidacloprid + bifenthrin	Indoxacarb	Lambda-cyhalothrin	Metaflumizone	Methoprene	Methoprene + hydramethylnon	Permethrin	Pyriproxyfen	Spinosad	Thiamethoxam	Thiamethoxam + lambda-cyhalothrin
	1B	3	1A	1B	4A	3 4A	3	3	3	2B	20	3 4A	22	3	22	7A	20 7A	3	7C	5	4A	3 4A
Ants	o[a]	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o	o		o	o
Centipedes		o	o	o			o	o	o			o		o				o				
Chiggers			o	o		o		o	o	o				o								o
Crickets	o	o		o			o	o	o		o	o	o	o				o				o
Earwigs	o		o	o			o	o			o	o	o	o				o				
Fleas	o	Δ	o	o			o	o	◊	o		o		◊				o		o	o	
Grasshoppers	o		o	o		o	o		o			o	o	o								o
Leafhoppers	o	o	o	o		o			o			o									o	
Millipedes		o	o	o			o	o				o		o				o				
Pillbugs	o	o		o		o	o	o	o			o		o				o				
Sowbugs		o	o	o		o	o	o	o			o		o				o				
Spiders			o				o	o	o									o				
Spittlebugs	o		o			o															o	
Ticks		o	o	o		o	o	o	o	o		o		o								
Yellowjackets	o						o	o										o				

* Insecticide Resistance Action Committee

[a] Labeled only for fire ant control in residential and commercial lawns.

[x] Not for use on residential lawns.

[y] Only spot treatments allowed on residential turf.

o denotes control

Δ denotes larvae control only

◊ denotes adult control only

1 denotes suppression

Table 4. IRAC codes, chemical classes and modes of action for insecticides.

IRAC* code	Chemical class	Mode of action
1A	carbamates	Acetylcholinesterase inhibitors
1B	organophosphates	
2B	fipronil	GABA-gated chloride channel antagonist
3	pyrethroids	Sodium channel modulators
4A	neonicotinoids	Nicotinic acetylcholine receptor antagonists
5	spinosyns	Nicotinic acetylcholine allosteric activator
6	avermectins	Chloride channel activators
7A	juvenile hormone analogues	Juvenile hormone mimics
7B	fenoxycarb	
7C	pyriproxyfen	
11B1	*Bacillus thuringensis*	Microbial disruptors of insect mid-gut membranes
11B2		
18A	diacylhydrazines	Ecdysone agonist/molting disruptors
20	hydramethylnon	Mitochondrial complex III electron transport inhibitor
22	indoxacarb metaflumizone	Voltage-dependent sodium channel blockers
28	diamides	Ryanodine receptor modulator

* Insecticide Resistance Action Committee

Table 5. Common names and trade names of biological turfgrass insecticides.

IRAC* code	Common name	Trade name
11B1	*B.t. var. aizawai*	Xentari
11B2	*B.t. var. kurstaki*	Biobit, Crymax, Dipel, Juvelin, Lepinox
Unclassified	*Bacillus popillae*	Milky Spore
Unclassified	Nematodes: *Steinernema* spp. and *Heterorhabditis* spp.	Millennium, BioVector, Nemashield

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Table 6. Common names and trade names of turfgrass insecticides with IRAC code.

IRAC* code	Common name	Trade name
1A	carbaryl	Sevin SL, Sevin 80WP, Sevin 10G
1B	acephate	Orthene T&O 75, Orthene T&O 97
1B	chlorpyrifos	Dursban 50W, Dursban Pro
1B	trichlorfon	Dylox 6.2G, Dylox 420SL, Dylox 80 T&O
2B	fipronil	Chipco Choice, Chipco Top Choice
3	bifenthrin	Allectus[z] G, Allectus GC Granular, Allectus GC SC, Allectus SC, Aloft[z] GC SC, Aloft GC G, Onyx, Onyx Pro, Talstar F, Talstar GC Flowable, Talstar GC Granular, Talstar One
3	cyfluthrin	Tempo 20 WP, Tempo Ultra SC, Tempo Ultra GC
3	cypermethrin	Demon WP, Demon Max
3	deltamethrin	DeltaGard GC, DeltaGard T&O, DeltaGard G
3	lambda-cyhalothrin	Lambda, Battle GC, Demand CS, Demand EZ, Demand G, Scimitar CS, Scimitar GC Tandem[z]
3	permethrin	Astro
4A	clothianidin	Arena 0.25G, Arena 0.5G, Arena 50WDG, Aloft[z] GC G, Aloft GC SC, Aloft LC G, Aloft LC SC
4A	dinotefuran	Zylam 20SG
4A	imidacloprid	Allectus[z] G, Allectus GC Granular, Allectus GC SC, Allectus SC, Imidacloprid, Merit 0.5G, Merit 2F, Merit 75WP, Merit 75WSP, Mallet
4A	thiamethoxam	Meridian 0.33G, Merdian 25WG, Tandem[z]
5	spinosad	Conserve SC
7A	s-methoprene	Firestrike[z], Extinguish, Extinguish Plus[z]
7B	fenoxycarb	Award Fire Ant Bait
7C	pyriproxyfen	Distance Fire Ant Bait
18A	halofenozide	Mach 2 2SC, Mach 2 1.5G
20	hydramethylnon	Firestrike[z], Extinguish Plus, SiegePro
22	indoxacarb	Advion Ant Bait, Advion Fire Ant Bait, Advion Insect Bait, Provaunt
28	chlorantraniliprole	Acelypryn, Acelypryn G
28	cyantraniprole	Ference
None	dicofol	Kelthane, Dicofol

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[z] Allectus = imidacloprid + bifenthrin; Aloft = clothianidin + bifenthrin; Tandem = thiamethoxam + lambda-cyhalothrin; Firestrike = s-methoprene + hydramethylnon; Extinguish Plus = s-methoprene + hydramethylnon.

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IPM1020

New 6/03; Revised 11/14/2M