IPM Planning Guide

reference

Insect Reference

GCSAA

INSECT REFERENCE

Annual white grubs

DESCRIPTION OF INSECT

- Asiatic garden beetle, *Maladera castenea*
- European chafer *Rhizotrogus majalis*
- Japanese beetle, *Popillia Japonica*
- Masked chafers, *Cyclocephala spp*.
- Oriental beetle, *Exomala orientalis*

Immature stage:

C-shaped, thick bodied, creamy white with yellow to brown head capsule

Chewing mouthparts, 3 pairs of short yellow legs

Size ranges from 3/8 in black turfgrass ataenius (BTA) to 2 in green June beetle (GJB)

Mature stage:

Beetles

Colors range from green to shades of tan, brown, or black

Stout and oval, size ranges from 3/16 in (BTA) to 1 in (GJB)

Forewings hardened, forming a shell like cover over membranous hindwings

Forelegs with teeth like projections used for burrowing

Damaging stage(s):

larvae (grubs) only; adult beetles can be problematic on surrounding ornamentals

Predictive models (degree day, plant phenology, threat temperatures, other)

Degree Days for first adult flights range from 900-1200

Damage appears in late summer and early falls as grass is heading into dormancy or experiencing drought stress

Life cycle:

1 year from egg to egg

Adults mate and lay eggs in mid-summer (June through August)

Eggs hatch in 2-3 weeks

Grubs (larval stage) molt twice becoming full grown by fall

Grubs move down into soil profile due to decreasing soil temperatures in late fall

Feeding resumes at the root zone as temperatures warm in the spring

Larvae move down in the soil to pupate, a few weeks later adults emerge

Conducive environmental conditions:

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Well irrigated, or areas with high soil moisture are conducive for survival of eggs and larvae

Damage occurs late summer to early fall

Damage occurs more rapidly when turf is subjected to other stresses (i.e. drought conditions)

Geographic distribution:

worldwide

DAMAGE CAUSED:

Plants attacked:

Roots of all turfgrass species are susceptible

Symptoms of damage:

Yellowing and thinning of grass similar to drought stress

Irregular dead patches of turf that continue to increase in size

Turf is easily pulled back due to loss of root zone

Predators (geese, skunks, armadillos, javelinas) rip up turf when foraging for grubs in high density areas

Larvae of GJB push up mounds of soil while feeding in the organic layer

Timing of damage:

Damage occurs late summer to early fall

Damage occurs more rapidly when turf is subjected to other stresses (i.e. drought conditions)

Insects that look similar; Pests that cause similar damage:

billbugs

MONITORING TECHNIQUES:

Monitor adult flight using pheromone traps for day active beetles (i.e. Japanese beetle, Oriental beetle) or black light trap for those active at night (i.e. masked chafers.)

For grubs, use a standard golf course cup cutter or flat spade to sample the upper 3-4" of soil under the turf. The majority of grubs can be found within the 2" of soil just below the thatch.

THRESHOLDS:

Thresholds will vary depending on the species of grub, turf species, management regime, and environmental conditions.

The majority of species will incite damage at 6-10 grubs per square foot.

MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference “Insecticide Resistance Management Groups.” Always consult the most recent version of all product labels before use.

White grub management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Chemical	Preventive treatment: target small grubs in the late spring	**Active Ingredient (Product)**	**Label signal word**	Products should be watered in
		Clothianidin (Arena)	Caution	
		Halofenozide (Mach 2)	Caution	
		Imidacloprid (Merit)	Caution	
		Imidacloprid + bifenthrin (Allectus)	Caution	
		Thiamethoxam (Meridian)	Caution	
	Curative control: target grubs as needed. Only moderate control will be achieved if grubs are mature	Acephate (Orthene)	Caution	Products should be watered in
		Carbaryl (Sevin)	Warning	
		Trichlorfon (Dylox)	Caution (granular) ; Warning (liquid)	

INSECT REFERENCE

Fire ants, *Solenopsis invicta*

DESCRIPTION OF INSECT

All stages live in underground colony, only adult workers are seen on the surface.

Immature stage:

Egg, larval and pupal stages are white and only occur in underground nest.

Mature stage:

Adult workers are typical ants with a reddish brown color and a darker abdomen (third and last segment of body). Worker size varies considerably and not a good character for identification.

Male and female reproductives are winged, but fly at night, and are not generally seen. Mating flights can occur at almost any time, but most often in spring or fall. Winged adults may be attracted to lights during mating flights.

Workers most frequently seen feeding on insects, sweet or oily substances

Damaging stage(s):

Mound building can be considered as damage in some situations. The main concern is the toxic sting delivered by adult workers.

Predictive models (degree day, plant phenology, threat temperatures, other)

Fire ants can be active year round where climate is warm or moderate. Cooler temperatures in northern part of range limit activity in winter. Mounds are generally present throughout the year.

Surface activity occurs when soil surface temperatures are between 65 and 950F. Activity is greatest May-September. Activity can occur both day and night, but is generally observed from dusk through the early morning hours during the hottest portion of the summer.

Bait treatments must be applied when workers are actively foraging. Prebaiting is the best method to determine when the ants are foraging.

Life cycle:

Mated queen continuously lays eggs. Queens can live up to 5 years.

Larval and pupal stages are cared for by sterile female worker ants.

Egg stage to adult worker takes approximately one month.

Fire ants only live in colonies, not as single ants.

Conducive environmental conditions:

warm rainy periods precede spring and fall mating flights and colony establishment

Geographic distribution:

native to limited portions of South America, invasive across the southern US

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DAMAGE CAUSED:

Mound building can be considered as damage in some situations, especially where appearance or playing surface is of critical importance. The main concern is the sting delivered by adult workers.

Symptoms of damage:

Mounds are generally the only indicator of infestation.

Timing of damage:

Mounds are present year round when not disturbed. The main period of mound building occurs during moist warm weather in early summer and again in fall. Mound building in summer is often hindered by dry weather; however, the underground portion of the colony remains viable.

Insects that look similar; Pests that cause similar damage:

Many species of ants look similar to the naked eye. Worker size can vary tremendously and is not a good diagnostic character. However, fire ants are one of the few ants that build soil mounds without ant apparent entry holes. The mounds are the best way to determine if fire ants are present.

MONITORING TECHNIQUES:

No specialized monitoring techniques are necessary. Mapping of the infestation based on the presence of mounds may be appropriate to determine where treatments are required at larger sites. Surface activity can be determined by prebaiting with greasy foods such as French fries or pieces of hot dog prior to the application of insecticidal baits for control.

THRESHOLDS:

There are no hard and fast thresholds for this pest. Fire ants should be controlled in areas where there is a high probability of contact with humans, or in areas where mounds are aesthetically unacceptable.

MANAGEMENT STRATEGIES:

Mapping of mounds is highly recommended to facilitate scouting and determine where insecticide treatments are required. Always consult the most recent version of all product labels before use. Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups."

Red Imported Fire Ant management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Cultural	N/A	Check deliveries of soil, sod and nursery plants to avoid new ant introductions at the site		
Biological	N/A	Currently, applications of biological agents are limited to state and federal agencies.		
Chemical*	Baits are the safest and most cost effective form of control. Apply baits when workers are actively foraging for food.	**Active Ingredient (Product)**	**Label signal word**	• Apply baits to dry soil and avoid rainfall and irrigation for 24-48 hours after application • Some baits take several weeks to reach maximum effectiveness. See label for specific time required.
		Abamectin (Affirm)	Caution	
		Hydramethylnon (Amdro)	Caution	
		Indoxacarb (Advion)	Caution	
		Methoprene (Extinguish)	Caution	
		Methoprene+ Hydramethylnon (ExtinguishPlus)	Caution	
		Priproproxifen (Distance)	Caution	
		Spinosad (Payback)	Caution	
	Mound drench is the fastest method to control colonies where immediate action must be taken.	Bifenthrin (Talstar)	Caution	• Apply adequate volume of liquid formulations as drench, or apply granules over mound and water in with a sufficient amount of water to ensure deep penetration
		Chlorpyrifos (Dursban)	Danger (WP), Caution (Liquid)	
		Cyfluthrin (Tempo)	Caution	
		Deltamethrin (Deltagard)	Caution	
	Contact insecticides can be broadcast as sprays or granules	Acephate (Orthene)	Caution	• Conserve native ants by avoiding wide area broadcast applications • Can be used as a surface dust treatment over top of mound where allowed by label
		Bifenthrin (Talstar)	Caution	
		Deltamethrin (Deltagard)	Caution	
		Fipronil (TopChoice)	**Caution**	

*chemical products shown in green type are considered reduced risk by the U.S. Environmental Protection Agency

INSECT REFERENCE

Nuisance ants, Lasius neoniger

DESCRIPTION OF INSECT

Small (1/10 inch long), brown ants that create troublesome mounds on greens and tees.

Usually a beneficial insect that eats the eggs of white grubs and caterpillars

Predictive models (degree day, plant phenology, threat temperatures, other)

Become active once average air temperatures reach 55F (13C)

Conducive environmental conditions:

Average air temperatures > 55F (13 C)

Presence of root aphids in soil

Geographic distribution:

worldwide

DAMAGE CAUSED:

Plants attacked:

Greens and tees: all turf varieties. Areas with sandy rootzone mixtures and located in sunny areas are most likely to suffer damage.

Symptoms of damage:

Small mounds, most abundant at the edges of greens and tees

Mounds are unsightly, dull mower blades, create a bumpy playing surface and can smother the turf underneath.

Timing of damage:

Springtime, through early summer. Mound building starts to decline in late summer.

MONITORING TECHNIQUES:

Scout for mounds weekly, beginning in spring when average air temperatures exceed 55F (13C)

THRESHOLDS:

None established.

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MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups." Always consult the most recent version of all product labels before use.

Nuisance ant management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Cultural	N/A	If ants are not causing significant damage with their mounds, try to avoid treating with insecticides! As mentioned above, they play an important role in natural control of even more serious pests such as grubs and caterpillars.		
Biological		No effective strategies known		
Chemical*	Curative: treat when mounds 1st detected	Active Ingredient (Product)	Label signal word	Focus treatments on greens perimeter and collars. Control lasts 4-6 wks.
		Bifenthrin (Talstar)	Caution	
		Cyfluthrin (Tempo)	Caution	
		Chlorpyrifos (Dursban)	Danger	
		Deltamethrin (Deltagard)	Caution	
	Curative: treat when mounds 1st detected.	**fipronil (Chipco Choice, Top Choice)***	Caution	Control lasts 3 months. Must be applied by a PCO
	Curative: spot treat mounds	hydramethylnon (MaxForce)	Caution	Season-long control. The most effective treatment.
		abamectin (Advance Granular Carpenter Ant Bait)	Caution	

*chemical products shown in green type are considered reduced risk by the U.S. Environmental Protection Agency

INSECT REFERENCE

Billbugs, *Sphenophorus* spp.

DESCRIPTION OF INSECT

Immature stage:

Soft-bodied, small white grubs

Slightly tapered abdomen with a brown head capsule.

Larvae have no legs, unlike true white grubs.

Range in size from 1.3mm – 10mm (0.05 - 0.4 inches)

Pupae are cream color at first and turn reddish brown before adult emergence.

Mature stage:

Typical weevil form with snout (i.e. bill), elbowed antennae, and elytra (hard wing covers).

10-15mm in length. Body is longer than it is wide.

Damaging stage(s):

larvae (grubs)

Predictive models (degree day, plant phenology, threat temperatures, other)

To date there is not a degree day model developed for billbugs. Depending upon species the adults become active in April and early May, mate and lay eggs. In the southern states hunting billbug adults have been observed year round.

Life cycle:

30 - 60 days from egg to adult (dependant on species and location)

Females lay eggs into holes in the stems of grass where they had been feeding.

Eggs hatch in 6 -10 days

Larvae live for 30 – 50 days

Young larvae feed up and down the stem of the grass.

Older larvae can tunnel into the crown of the plant to feed and kill it.

Larvae pupate in the soil near the surface and emerge in 8-10 days.

Conducive environmental conditions:

temperatures above 65F (18C)

Geographic distribution:

North America

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DAMAGE CAUSED:

Plants attacked:

Common name	Host plants
Bluegrass billbug *Sphenophorus parvulus*	Bluegrass, rye, fescue, bentgrass (occasionally) zoysia
Hunting billbug *S.venatus vestitus*	Zoysia & hybrid Bermuda. Occasionally on bahia, centipede & St. Augustinegrass
Phoenician billbug *S.phoeniciensis*	Bermuda, zoysia and kikuyugrass
Denver billbug *S. cicatristriatus*	Cool-season turf, esp. bluegrass and ryegrass

Symptoms of damage:

Stems turn straw color as they die.

Small patches of dead grass that resemble dollar spot.

Larger patches of dead grass that can be mis-diagnosed as white grub damage, late green up, drought damage.

Tufts of grass will easily lift from the rest of the sod mat.

Timing of damage:

Most symptoms of damage appear in late June and July or when the grass begins stress from the summer heat.

Insects that look similar; Pests that cause similar damage:

White grub larvae maybe mistaken for billbugs. The key difference is the presence of legs on white grubs while they are absent from billbug larvae.

Billbug damage can be mistaken for white grub damage and/or dollar spot damage.

Slow green up or winter kill in warm season grass also looks similar to billbug damage.

MONITORING TECHNIQUES:

Soapy water flush for adults. Begin weekly soap flushes in the springtime, once average air temperatures exceed 65F (18C).

Adults are very active and can be seen walking across side walks and cart paths in the spring once temperatures warm up.

THRESHOLDS:

There are no thresholds for this pest.

Turf can tolerate very high numbers with out any obvious signs of damage, so it is usually best to wait until early signs of damage are observed.

If damage is noted adult billbugs may not be present.

Investigation of the stem and crown of the grass will then be needed to detect the larvae.

MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups." Always consult the most recent version of all product labels before use.

Billbug management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Cultural	N/A	If infestations are light, and/or if damage is minimal, turf can sometimes "grow out" of the damage, especially if the turf is babied with more frequent irrigation and light fertilizer applications		
Biological	N/A	Use endophyte enhanced seed, if available		
Chemical*	Preventive control: target grubs in springtime, about 4 wks after adults 1st seen	**Active Ingredient (Product)**	**Label signal word**	
		Imidacloprid (Merit)	Caution	
		Halofenozide (Mach 2)	Caution	
		Clothianidin (Arena)	Caution	
		Thiamethoxam (Meridian)	Caution	
	Curative: target adults in springtime before they lay eggs	Bifenthrin (Talstar)	Caution	
		Chlorpyrifos (Dursban)	Danger	
		Cyfluthrin (Tempo)	Caution	
		Deltamethrin (Deltagard)	Caution	
		Lambda cyhalothrin (Scimitar)	Caution	
	Curative and preventive: treat in spring, soon after adults first appear	Imidacloprid + bifenthrin (Allectus)	Caution	

INSECT REFERENCE

Black cutworm, *Agrotis ipsilon*

DESCRIPTION OF INSECT

Immature stage:

Caterpillars are relatively thick bodied, and reach 1.75 inches in length and 1/4 inch in width when mature.

Color varies from dark gray to black in upper half of body, without distinctive markings other than a pale stripe down the middle of the back and a few randomly scattered bristles. The caterpillar is otherwise hairless. The underside of the caterpillar is light gray. Under a hand lens, the skin appears bumpy and greasy.

Spiracles (small breathing holes on the thorax and abdomen) are black.

Three pairs of true legs on thorax (behind head); five pairs of prolegs towards the rear of the insect, on the abdomen.

Mature stage:

Adults are thick bodied, dark colored moths that fly at night. Their wingspan ranges from 1 – 1.75 inches.

The forewings are dark gray, brown or black and have a distinctive, dark colored marking in the shape of a dagger in the center of each forewing.

Hindwings are off-white or dirty white.

Damaging stage(s):

(caterpillars) only; adult moths do not feed

Predictive models (degree day, plant phenology, threat temperatures, other)

Caterpillars hatch once average air temperatures reach 55F (13C), and multiple overlapping generations can occur as long as temperatures are above this threshold.

Damage frequently appears following aeration, though caterpillars are typically present, without causing damage, before aeration

Life cycle:

40 – 60 days from egg to egg

Females lay eggs during the nighttime, usually on the tips of grass blades or on weeds such as curled dock or yellow rocket mustard.

Eggs hatch in 3-6 days

Larvae live for 20 – 40 days

Young larvae feed directly on leaf blades, causing little to no obvious damage

Older larvae are voracious feeders, eating up to a handful of foliage per night. These larvae reside during the day in the thatch and upper soil profile, where they construct silk-lined burrows. These are frequently found in aeration holes.

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Larvae pupate in the larval burrow and the adult moth emerges roughly 2 weeks later.

Conducive environmental conditions:

temperatures above 55F (13C)

Geographic distribution:

worldwide

DAMAGE CAUSED:

Plants attacked:

Foliage of cool-season turf on greens, tees and sometimes fairways. Bentgrass, Poa annua, tall fescue and ryegrass are preferred. Cutworms do not survive well on Kentucky bluegrass.

Symptoms of damage:

small dead patches of turf that can resemble dollar spot

sunken areas or pockmarks that resemble ball marks.

Pecking by birds

Damage frequently occurs around aeration holes or spike mark holes, where cutworms burrow during the day.

Timing of damage:

Damage is frequently most obvious following aeration

Damage occurs when average air temperatures are above 55F (13C)

Insects that look similar; Pests that cause similar damage:

Sod webworms are thinner bodied, and have prominent spots throughout the body.

Fall armyworm has obvious striping patterns and pale colored spiracles surrounded by a whitish ring.

Dollar spot causes similar damage, but produces mycelium when turf is incubated overnight.

MONITORING TECHNIQUES:

Soap flush for larvae: This is the most useful of the monitoring techniques for cutworms. See IPM Template reference on “Monitoring for insects with soap flushes”.

Pheromone traps with female sex attractant. Monitoring for larvae should begin two weeks after the first peak of males is trapped.

THRESHOLDS:

There are no hard and fast thresholds for this pest. Turf, even on greens, can tolerate very high numbers without any obvious signs of damage, so it is usually best to wait until early signs of damage are observed. Following use of a soap flush to confirm the presence of cutworms, treatments can be triggered.

MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups." Always consult the most recent version of all product labels before use.

<table>
<tr><td colspan="5">Black cutworm management strategies</td></tr>
<tr><td>TYPE</td><td>TIMING/ THRESHOLD</td><td colspan="2">PRACTICE</td><td>COMMENTS</td></tr>
<tr><td>Cultural</td><td>N/A</td><td colspan="2">Utilize tolerant/resistant turf types including Kentucky bluegrass
Remove clippings</td><td></td></tr>
<tr><td>Biological</td><td>Apply when 1st small larvae are detected with soap flush</td><td colspan="2">Beneficial nematode products based on Steinernema carpocapsae (Millenium). For other suppliers, see http://www.oardc.ohio-state.edu/nematodes/nematode_suppliers.htm</td><td>Moderate efficacy</td></tr>
<tr><td rowspan="9">Chemical</td><td rowspan="9">Apply curatively when damage threshold is reached</td><td>Active Ingredient (Product)</td><td>Label signal word</td><td rowspan="9">Include treatment of a 20 – 30 foot buffer zone around greens and tees to avoid re-infestation
Apply in 1 – 2 ga/1000 sq ft.
Do not water in</td></tr>
<tr><td>Bifenthrin (Talstar)</td><td>Caution</td></tr>
<tr><td>Cyfluthrin (Tempo)</td><td>Caution</td></tr>
<tr><td>Chlorpyrifos (Dursban)</td><td>Danger</td></tr>
<tr><td>Deltamethrin (Deltagard)</td><td>Caution</td></tr>
<tr><td>Halofenozide (Mach 2)</td><td>Caution</td></tr>
<tr><td>Lambda cyhalothrin (Scimitar)</td><td>Caution</td></tr>
<tr><td>Spinosad (Conserve)</td><td>None required</td></tr>
</table>

INSECT REFERENCE

Black turfgrass ataenius, *Ataenius spretulus*

DESCRIPTION OF INSECT

Immature stage:

Small (less than 1/4 inch maximum length) white to transparent grub with 6 legs, light brown head.

Frequently lies in “C” shaped position

Lives in soil; feeds on roots

Mature stage:

Small (1/4 inch long), hard-bodied black beetle with short antennae and striations on wings

Frequently found walking on surface of greens, especially on warm and sunny days

3 pair of legs

The color of ataenius beetles may be reddish brown for the first day or two after they emerge from their pupae in the soil. After this, they remain black for the duration of their lives.

Damaging stage(s):

Grubs only

Predictive models

Monitor average air temperatures in the springtime. When there are 3 or more consecutive days of 65F, be prepared for grubs to appear within the next 2 -4 weeks.

Life cycle:

Eggs are laid in the soil by adult beetles.

Grubs hatch from the eggs and spend their entire lives in the soil. They live 4 – 8 weeks, depending on soil temperatures.

Once grubs reach their maximum size, they form pupae in the soil. Soon afterwards, adult beetles emerge and crawl to the surface of the turf, where they begin to look for mates.

In warmer climates, there can be 2 or more generations of ataenius per year. In cooler climates, there is only one generation per year.

Conducive environmental conditions:

Average air temperatures >65F (18C)

High organic matter in soil (>2% on greens; >6% on other turf)

Location near livestock operation (horses, chickens, cows, etc). Ataenius are dung beetles and are drawn to the odor of manure and to high organic matter environments

Use of organic fertilizers

Damage will develop more rapidly when turf is stressed due to:

High soil salts (salinity)

Compaction or traffic

Heat or drought

Geographic distribution:

Most of North America. Related insects cause problems on golf course turf in other regions of the world.

DAMAGE CAUSED:

Plants attacked:

All varieties of turf are attacked, but damage develops only on cool season turf. This is due to the relatively shallow root system of cool-season turf, which cannot withstand sustained feeding by ataenius grubs.

Animals damage due to birds, reptiles or mammals searching for grubs and adults of the ataenius can occur on any turf type.

Symptoms of damage:

Initial symptoms are small areas of thin, yellowing or wilting turf. As grub feeding continues, affected patches grow in size and turf eventually dies. Turf can be easily picked up by hand, due to destruction of the root system.

Timing of damage:

Late spring, summer and early fall, as long as average air temperatures are greater than 65F (18C)

Insects that look similar; Pests that cause similar damage:

Adult black turfgrass ataenius can be confused with:

- Ground beetles: ground beetles differ in their size (usually larger), their long, thin antennae and their rapid running movements
- Aphodius beetles: these closely related beetles have a similar size and shape, but are lighter colored — usually light to dark brown.

Larval (grub) black turfgrass ataenius can be confused with:

- Newly hatched larvae of other white grub species including Japanes beetle, chafers, Oriental beetle, Asiatic beetle or May/June beetles). Although these grubs will eventually become much larger than ataenius grubs, when they are first hatched, they are difficult to distinguish from ataenius.

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MONITORING TECHNIQUES:

Adults: Adult beetles can be detected by examine the surface of greens, in clippings in mower baskets, or by applying a 1% soap solution (see Reference “Monitoring for insects with soap flushes”) to the turf surface.

Larvae (grubs): The only way to locate grubs is to cut or peel away the turf surface. Grubs usually reside near the thatch/soil interface. Grubs are typically found in areas showing signs of damage and/or areas that were infested in previous years. Other areas to start looking include locations where animals have been digging for insects, wet and poorly draining areas, areas where turf is stressed for other reasons.

THRESHOLDS:

There are no generally accepted threshold levels. On greens, a few ataenius grubs per square foot can cause damage on cool-season turf. On higher mown turf, higher densities can be tolerated.

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MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups." Always consult the most recent version of all product labels before use.

TYPE	TIMING/ THRESHOLD	PRACTICE	
Cultural	N/A	Avoid stressed turf through management of irrigation, traffic, black layer, drainage salinity Avoid organic fertilizers To stop animals from digging for grubs, apply Milorganite to turf at labeled rates.	
Biological			
Chemical	Preventive: target grubs w/ applications made late spring/early summer after average air temperatures >65F (18C)	Active Ingredient (Product)	Label signal word
		clothianidin (Arena)*	Caution
		halofenozide (Mach 2)	Caution
		imidacloprid (Merit)	Caution
		imidacloprid + bifenthrin (Allectus)	Caution
		thiamethoxam (Meridian)	Caution
	Curative: target adults once they are detected	Bifenthrin (Talstar)	Caution
		Cyfluthrin (Tempo)	Caution
		Chlorpyrifos (Dursban)	Danger (WP); Caution (liquid)
		Deltamethrin (Deltagard)	Caution
		Lambda cyhalothrin (Scimitar)	Caution
	Curative: target grubs once they are detected	Acephate (Orthene)	Caution
		Clothianidin (Arena)*	Caution
		Imidacloprid (Merit)	Caution
		Thiamethoxam (Meridian)	Caution
		Trichlorfon (Dylox)	Caution (granule); Warning (powder)

INSECT REFERENCE

Earthworms

DESCRIPTION OF INSECT

All stages live in the soil and are only seen on the surface after rain or irrigation, or rarely at night.

Immature stage:

Eggs are laid underground in cocoons

• All stages appear similar and vary only in size

Mature stage:

Adults are elongated cylindrically shaped Annelids, generally with a pinkish color.

Damaging stage(s):

Juveniles and adults can produce castings at the soil surface

Predictive models (degree day, plant phenology, threat temperatures, other)

Earthworms are active at the surface when the soil is moist and soil temperatures are moderate. Generally most activity is seen in spring and fall with less activity during the hot dry summer months.

• Castings produced at the surface are the best indicator of earthworm activity. However, feeding activity by birds, moles and other worm-eating mammals is also an indicator.

Life cycle:

Many earthworms are long-lived with a multi-year life cycle.

• Eggs are generally laid in spring and are contained in a cocoon produced by the female.

Occurrence and surface activity are primarily influenced by soil moisture and temperature

Conducive environmental conditions:

moist soil conditions, high levels of soil organic matter.

Geographic distribution:

worldwide

DAMAGE CAUSED:

Plants attacked:

The primary concern are the castings (mounds of extruded waste soil) deposited on the surface in short mowed, high maintenance turfgrass areas (such as greens and tees) where appearance or playing surface is of critical importance. Mowing during moist soil conditions can smear soil over growing grass and affect growth and appearance.

Earthworms exiting the soil and moving to adjacent impervious surfaces (sidewalks) during rainfall and irrigation can also be considered as a problem in some areas.

Symptoms of damage:

Castings produced at the soil surface.

• Earthworms on sidewalks

Timing of damage:

Castings can be produced at any time of year, but most often occur in spring and fall.

• Earthworm may exit the soil in response to high soil moisture caused by rainfall and irrigation.

Pests that look similar; Pests that cause similar damage:

Some beetles produce small mounds of soil, but these mounds do not have an 'extruded' appearance.

MONITORING TECHNIQUES:

Soap flush, mustard solution flush or heavy application of irrigation can cause earthworms to surface.

Casting counts can be used as an index of abundance

THRESHOLDS:

There are no thresholds for earthworms. Earthworms are generally considered as beneficial organisms and are not a problem in most turfgrass situations. The primary concern are the castings (waste soil mounding) deposited on the surface in short mowed, high maintenance turfgrass areas such as greens and tees where appearance or playing surface is of critical importance. Low to moderate populations can be considered undesirable in these situations, especially on greens where ball roll can be affected.

INSECT REFERENCE

MANAGEMENT STRATEGIES:

Earthworms are most often a problem where moist soil conditions occur. Improving drainage reduces soil moisture and earthworm activity. Where drainage is not a viable solution, flooding can cause earthworms to come to the surface where they can be preyed upon by birds. No pesticides are labeled for earthworm control.

<table>
<tr><td colspan="5">Earthworm management strategies</td></tr>
<tr><td>TYPE</td><td>TIMING/ THRESHOLD</td><td colspan="2">PRACTICE</td><td>COMMENTS</td></tr>
<tr><td>Cultural</td><td>N/A</td><td colspan="2">Reduce soil moisture by managing irrigation or improving drainage
Sand topdressing
Avoid organic fertilizers, manage organic matter</td><td></td></tr>
<tr><td>Biological</td><td>N/A</td><td colspan="2">——-</td><td></td></tr>
<tr><td rowspan="3">Chemical</td><td rowspan="3">There are no pesticides registered for control of earthworms. However, those listed to the right are registered for use on golf course turf and have been shown to be effective against earthworms</td><td>Active Ingredient (Product)</td><td>Label signal word</td><td rowspan="3"></td></tr>
<tr><td>Carbaryl (Sevin)</td><td>Warning</td></tr>
<tr><td>Thiophanate-methyl (Cleary’s 3336)</td><td>Caution</td></tr>
</table>

Fall armyworm, *Spodoptera frugiperda* (J.E. Smith)

DESCRIPTION OF INSECT

All stages except the pupae are above ground.

Eggs:

Eggs are small and circular (0.2 in) and laid in clusters of about 50-250. The eggs are initially greenish-white when first laid, but turn almost black just prior to hatching. The egg masses appear fuzzy due to scales form the female's body.

Immature stage:

Caterpillars: Larvae are green to brown to almost black. The head is dark and marked by a conspicuous yellow or white inverted "Y" on the front of the head. Unlike the black cutworm, fall armyworms have a black stripe on each side that runs the length of the body and a less prominent faint stripe that runs the length of the body down the middle of the "back". Each abdominal segment has four small, but distinct dots. When fully grown, the caterpillars range in size from just over 1 ¼ inches up to almost 2 inches long.

Pupae are about ½ inch long and reddish brown to near black. The pupae are always found in the soil.

Mature stage:

Adults are moths with a wingspan of 1 ½ inches. Front wings are mottled dark gray with light and dark markings. There is a distinct white blotch near the tip of each front wing. Markings on the male are more pronounced than the female with males having a more gray color and a light diagonal marking on the forewing, the female is more brownish. The back wings are white.

Damaging stage(s):

The caterpillars are the damaging stage and typically cause the most severe damage during the last 3-5 days prior to pupation.

Predictive models (degree day, plant phenology, threat temperatures, other)

Moths arrive from spring through mid summer depending upon location. Since this insect does not overwinter in most areas of the U.S. it is difficult to forecast its occurrence. Timing of outbreaks are influenced by migratory patterns of moths each spring.

Weekly soap flush sampling starting in late spring in the southern U.S. and mid summer in the northern U.S. is the best method to determine if fall armyworm eggs have hatched in your area.

Life cycle:

The fall armyworm has multiple generations per year depending upon the location. This insect overwinters in south Florida and along the extreme southern Gulf Coast. Each spring moths migrate north and the timing and extent of these migrations is dependent upon spring weather patterns. In the Southeast, damage may occur in May and three

or more generations may occur. Whereas in areas further north in the U.S. may not see damaging populations until August and only one generation occurs.

Females lay eggs on light-colored objects including materials, foliage of plants, flags on golf greens, fences and buildings, metal gutters, and other objects. The moths are attracted to lights and egg laying is often more common in those areas.

Eggs hatch in 2-10 days and most eggs in a mass hatch about the same time.

The small caterpillars spin down to the turf on threads and feed in the morning and early afternoon.

As the caterpillars become larger after 2-3 weeks they may feed more at night to avid predation by birds. After 3-4 weeks the caterpillars burrow into the soil to pupate.

Moths emerge from the pupae in 10-14 days.

Conducive environmental conditions:

warm, wet springs with weather fronts moving up from the South may lead to earlier outbreaks. Wet spring also appear to be detrimental to natural enemies of the fall armyworms.

Geographic distribution:

South, Central and North America

DAMAGE CAUSED:

Plants attacked:

Although bermudagrass is most commonly damaged, falll armyworms feed on most grasses. Infestations are most commonly associated with lush, green, dense grass.

Symptoms of damage:

Young larvae skeletonize the tenderest leaf tissue.

Older larvae consume most of the leaf tissue

Warm season turfgrass may take on the appearance of frost or freeze damage.

Presence of or pecking in turf by birds.

Larvae move in groups and often is definite line of damage starting at edge of turf

Damage often associated with lights.

Growing tips of cool season turf is often affected and serious damage results.

Timing of damage:

Visible damage typically begins in mid summer through fall.

Since this pest must migrate back into areas each spring there is usually no relationship between infestation from one year to the next..

Links to photographs, illustrations of damage

http://www.turffiles.ncsu.edu/news/insects/FallArmyWorm.htm

INSECT REFERENCE

Insects that look similar; Pests that cause similar damage:

Areas with a serious fall armyworm infestations may have a similar appearance to drought stress or in the case of warm season turf, may resemble frost damage. However, grub infestations are much more common in cool-season grass and much less common in warm season turf. Mole cricket damage mainly limited to sandy soils and warm season turfgrass.

Some surface-dwelling crickets look similar, but are much darker in coloration and do not have large front feet modified for digging.

MONITORING TECHNIQUES:

Fall armyworms may feed actively during the day when small, but have a tendency to be more reclusive and to avoid feeding during the day when they become larger (and more damaging). The presence of birds in a turf area may be an indicator of fall armyworm presence. Weekly soap flush sampling (see IPM Template Reference “Monitoring for insects with soap flushes”) starting in late spring in the southern U.S. and mid summer in the northern U.S. is the best method to determine if fall armyworm are present in turfgrass.

THRESHOLDS:

There are no hard and fast thresholds for this pest. Some fairways can tolerate moderate infestations, but infestations usually move in from the rough and numbers as high as 100 per square yard can occur. Cool season turf is likely to be more seriously damage. Established bermuda usually recovers, but may take several weeks for regrowth to cccur. Newly-sodded, seeded or sprigged areas are prime areas for damage.

MANAGEMENT STRATEGIES:

Watching for birds on turf, observing large numbers of moths flying around lights, and green fecal pellets in the turf can be indicators of a fall armyworm infestation. Use of soapy water flushes to confirm presence is critical. Mowing will mechanically kill some larvae. Mowing also reduces depth and thickness of turf and allows for better coverage with spray applications. Irrigation prior to treatment may stimulate caterpillars to be more active during application. Always consult the most recent version of all product labels before use.

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups."

<table>
<tr><td colspan="5">Fall armyworm management strategies</td></tr>
<tr><td>TYPE</td><td>TIMING/ THRESHOLD</td><td colspan="2">PRACTICE</td><td>COMMENTS</td></tr>
<tr><td>Cultural</td><td>N/A</td><td colspan="2">Mowing</td><td></td></tr>
<tr><td>Biological</td><td>Apply when adult stage is detected, or by damage, or with soap flush</td><td colspan="2">Beneficial nematode products based on Steinernema scapterisci.
For current suppliers, see http://www.oardc.ohiostate.edu/nematodes/nematode_suppliers.htm</td><td>• Pre and post application irrigation critical
• Not recommended for heavy infestations</td></tr>
<tr><td rowspan="8">Chemical</td><td rowspan="8">Apply when small larvae are first detected with soap flush for best results</td><td>Active Ingredient (Product)</td><td>Label signal word</td><td rowspan="8">Sprayable formulations typically outperform granular formulations Sprayable formulations typically outperform granular formulations
Apply while armyworms are less than 1 inch long for best control.</td></tr>
<tr><td>Acephate (Orthene)</td><td>Caution</td></tr>
<tr><td>Bifenthrin (Talstar)</td><td>Caution</td></tr>
<tr><td>Carbaryl (Sevin)</td><td>Warning</td></tr>
<tr><td>Cyfluthrin (Tempo)</td><td>Caution</td></tr>
<tr><td>Deltamethrin (Deltagard)</td><td>Caution</td></tr>
<tr><td>Indoxacarb (Provaunt)</td><td>Caution</td></tr>
<tr><td>Lambda cyahalothrin (Scimitar)</td><td>Caution</td></tr>
</table>

INSECT REFERENCE

Green June beetle, Cotinus nitida (L.)

DESCRIPTION OF INSECT

Eggs, larvae, and pupae are found in the soil, but adults are present above ground. Green June beetles have a one year life cycle.

Eggs:

Eggs are dull white when laid and about 1/16 inch in diameter. They absorb moisture from the soil and increase in size to about 1/8 inch. Eggs are laid in a cluster of 10-30 eggs and a female may lay from 60-75 eggs. Eggs hatch in about two weeks.

Immature stage:

White grubs: Larvae are unique in that they have stiff abdominal bristles on the grubs back, short legs, a rather consistently uniform body shape with parallel sides. The grubs have three instars and the approximate sizes are: 1st instar – ¼ in., 2nd instar – ¾ in., and 3rd instar – 2 in. These grubs have the unique habit of emerging from the soil and crawling on their backs. They construct vertical tunnels in the soil.

Pupae are about 1 inch long and whitish at first, but darkening through time. The pupal cell resembles a bird's egg and is covered with soil particles held together by a sticky secretion.

Mature stage:

The adult beetles are quite large (¾ to 1 inch long) and vary in color of the wings from dull brown to velvety forest green. The outer margins of the wings have a thin band around them that varies from tan to orange-yellow. The adults prefer to feed on overripe fruits such as peaches, tree sap, and other sugary foods.

Damaging stage(s):

The larvae or grubs are the damaging stage and almost exclusively, the third instar is the damaging stage in late summer through fall and again in the spring.

Predictive models (degree day, plant phenology, threat temperatures, other)

There are no predictive models for green June beetle grubs. The timing of beetle flights and grub appearance is consistent from year to year. Populations often cycle through high to low levels every 5 or 6 years.

Life cycle:

Beetles emerge in the summer from pupal cells. The adults fly over open grassy areas and often fly early in the morning and rest on vegetation or under thatch at night. Eggs are laid in mid summer and hatch in two weeks, Grubs grow to the 3rd instar by late summer, early fall and overwinter in that stage. The grubs feed briefly in the spring before pupating.

Conducive environmental conditions:

Too much thatch, composted yard waste, and the use of manure-based fertilizers in the spring and summer can create a more attractive and more favorable site for green June beetle grub infestations. Prefers light-textured soils and requires at least 20 in. of rain or irrigation per year.

Geographic distribution:

Eastern United States into Texas and small area in southern California. Through the transport of plant materials and soil, this pest has the potential to spread to additional areas.

DAMAGE CAUSED:

Plants attacked:

Green June beetle grubs attack all turf types and particularly prefer moist, light-textured soils with higher organic matter. Little feeding on the roots actually occurs.

Symptoms of damage:

Vertical tunnels cause mounds of soil to be produced. Tunnels may extend 18 inches deep.

Thinning of turf, weed encroachment, drying out of soil

Tunneling near the soil surface, loosening of soil

Presence of or damage from moles, raccoons, skunks, birds.

Grubs found on sidewalks, garages, etc in the morning

Timing of damage:

Visible damage typically begins in late summer through fall.

Damage will continue in fall until soil becomes too cool for activity

Damage will appear again in spring as soil warms until grubs pupate in late spring.

Preferred sites often suffer from infestations year after year, but often cycle through low and high years of damage every 3-5 years.

Insects that look similar; Pests that cause similar damage:

Areas with a serious green June beetle infestation may have a similar appearance to mole cricket or earthworm infestations. Drought stress may also resemble the affect of grub tunneling.

MONITORING TECHNIQUES:

Soap flush will NOT bring white grubs to the surface. Beetles are often noticed flying or “dive-bombing” turf areas in the morning. The first signs of small mounds of soil pushed up should be investigated. Watch for signs of a large, dark blue wasp flying in a figure 8 pattern about one foot above the turf. This is a parasitic scoliid wasp that is present when green June beetle grub populations infest an area.

INSECT REFERENCE

THRESHOLDS:

There are no hard and fast thresholds for this pest. Some turfgrass may be able to tolerate 6 to 7 grubs per square foot and turf with thicker blades and higher cut tend to hide the damage better. Most turfgrass will recover given proper soil moisture.

MANAGEMENT STRATEGIES:

Management of thatch and organic matter can help reduce the attractiveness of an area to this pest. Composted yard waste or manure based fertilizers applied in the spring or early summer will increase the likelihood of an infestation. Treating an infestation in late summer/early fall once the grubs are large with a surface insecticide such as carbaryl (Sevin) will provide good control, but the grubs die on the surface within 12 hours. The next few days will consist of thousands of dead unsightly and smelly grubs lying on the surface.

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups."

Green June beetle management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Cultural	N/A	Avoid excessive thatch and the presence of organic matter, particularly in summer when adults are flying		
Biological	Apply when grubs are small (late summer)	Entomopathogenic nematodes. For current suppliers, see http://www.oardc.ohiostate.edu/nematodes/ nematode_suppliers.htm		Pre and post application irrigation critical Not recommended for heavy infestations
Chemical	Apply during egg laying, egg hatch or when grubs are small	Active Ingredient (Product)	Label signal word	Sprayable and granular formulations typically perform the same Irrigation post-treatment is recommended for all products except carbaryl
		Carbaryl (Sevin)	Warning	
		Clothianidin (Arena)	Caution	
		Halofenozide (Mach 2)	Caution	
		Imidacloprid (Merit)	Caution	
		Imidacloprid + bifenthrin (Allectus)	Caution	
		Thiamethoxam (Meridian)	Caution	

INSECT REFERENCE

May and June beetles (2 and 3 year grubs), Phyllophaga spp.

DESCRIPTION OF INSECT

Immature stage:

Difficult to identify to species.

C – shaped larvae with 3 pairs of well developed legs

Large brown head capsule with well developed mandibles.

Distinguished from other white grubs by the broad Y-shaped anal slit and two rows of parallel bristles that point toward each other on the raster (bottom side of rear end near anus).

Range from 6.3 mm – 38 mm (3/16 – 1 ¼ inches) fully grown.

Mature stage:

Adults vary in color from light brown to almost black depending upon species.

There bodies support different amounts of hair from none at all to dense stands.

Size varies from 10.5 mm – 30 mm (3/8 – 1 1/8 inches).

Damaging stage(s):

mainly larvae damage turf but adults maybe found feeding on foliage of certain grasses, trees, and shrubs.

Predictive models (degree day, plant phenology, threat temperatures, other)

No degree day model exists for predicting flights of May/June beetles. The adults are dependant upon soil moisture along with warmer temperatures and large flights of beetles may be noted with in days of a large rain.

A black light trap may be used to help monitor for adult flights to help determine when egg lay will occur.

Life cycle:

1 – 3 years from egg to adult.

Females lay eggs individually in earthen cells usually during the nighttime, although there are a few daytime active species.

Eggs are small white ovals that become more round with age. 2 mm in size (5/64 inch).

Larvae develop through three instars in the ground and feed on organic matter and available roots.

They proceed through the first two instars and pupal stage rather quickly, spending most of their lives as 3rd instars

Larvae will migrate deeper into the soil profile to over winter and migrate back up to the surface in the spring.

INSECT REFERENCE

Depending upon the species and the year of development the larvae will over winter as 2nd or 3rd instars, in some cases as pupae or adults.

Adults typically emerge from April-June to mate, although in the southern regions some species can be found flying into the fall.

Conducive environmental conditions:

Adult mating flights are dependant upon warming temperatures and adequate soil moisture.

Geographic distribution:

North and South America

DAMAGE CAUSED:

Plants attacked:

Root systems of cool-season and warm-season grasses on greens, tees and fairways.

Symptoms of damage:

Damaged turf wilts under drought stress and eventually dies in uneven patches.

In cases of a high density grub population the sod maybe lifted free from the root system.

Mammals also cause severe damage when searching for white grubs. They root up and dig unsightly holes in turfgrass.

Timing of damage:

Damage is most obvious during the hottest days of the summer when the lack well developed root system stresses the grass.

Damage due to mammals usually noted in last half of summer or in fall when larvae are larger.

Links to photographs, illustrations of damage

http://www.oznet.ksu.edu/dp_hfrr/TURF/insects%20grub%20damage%20on%20soccer%20field%202.jpg

• http://hcs.osu.edu/images/cd0005/cd0005-06.jpg

Insects that look similar; Pests that cause similar damage:

All white grubs look similar in appearance this includes; Japanese beetle, masked chafers, green june beetle, oriental beetle, black turfgrass ataenius.

Some of these maybe ruled out according to geographic location.

Adult beetles of each of these larvae can be more easily identified from each other.

MONITORING TECHNIQUES:

Black light trapping of adults can give an indication of oviposition.

Pheromones are not currently available but may be available in the near future.

INSECT REFERENCE

THRESHOLDS:

There are no thresholds supported by experimentation. Depending upon the turf type, region, and moisture availability thresholds can range from 4-12 per 0.1 m^2 (1 ft^2) for direct damage from the larvae.

In the case of mammal damage the threshold is 0.

MANAGEMENT STRATEGIES:

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups." Always consult the most recent version of all product labels before use.

May and June beetle management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Chemical	Target young larvae (grubs) in late spring	**Active Ingredient (Product)**	**Label signal word**	
		Clothianidin (Arena)	Caution	
		Halofenozide (Mach 2)	Caution	
		Imidacloprid (Merit)	Caution	
		Thiamethoxam (Meridian)	Caution	

INSECT REFERENCE

Southern mole cricket, *Scapteriscus borellii*

Tawny mole cricket, *Scapteriscus vicinus*

DESCRIPTION OF INSECT

All stages live in the soil and are rarely see on the surface.

Immature stage

Nymphs of both species are similar in appearance to adults, but lack wings. Nymphs proceed through 8-10 instars ranging in size from 0.2 to 1.25 inches in length. Each instar is progressively larger with wing buds apparent on later instars.

Color varies from gray to brown. Pronotum (large shield behind head) with distinctive mottling or spots, depending on species and location.

Mature stage

Adults are somewhat cylindrically shaped, light colored crickets 1.26 to 1.38 inches in length.

Adults have two pairs of wings, but only fly at night during two brief flight periods in fall and early spring. Spring flights are generally more extensive than fall flights.

Damaging stage(s)

Both nymphs and adults cause damage

Links to photographs, illustrations of insects

ADULT Tawny Mole Cricket: http://molecrickets.ifas.ufl.edu/mcri0039.htm

ADULT Southern Mole Cricket: http://molecrickets.ifas.ufl.edu/mcri003e.htm

Predictive models (degree day, plant phenology, threat temperatures, other)

Both species hatch in spring/early summer. TMC hatches slightly earlier (June), SMC hatches slightly later (July) and has a protracted hatch. Egg-laying and hatch timing are affected by soil moisture.

Preventative treatments should be timed to slightly precede or coincide with peak hatch.

Weekly soap flush sampling in June and early July is the best method to determine when hatch is occurring, and the best time to treat.

Life cycle:

Both species have a one-year life cycle throughout most of range. SMC may have more than one generation in southern Florida.

Females lay eggs in underground chambers in spring.

Eggs hatch in approximately 20 days, depending on soil temperature and moisture.

Nymphs are present from June hatching until winter or spring

INSECT REFERENCE

Nymphs of TMC become adults in late fall, nymphs of SMC become adults in early spring

Nymphs generally cause no visible damage until mid to late July

Conducive environmental conditions:

warm, wet springs may lead to earlier hatch date

Geographic distribution:

worldwide

DAMAGE CAUSED

Plants attacked:

Roots and stems of warm-season turf on fairways, greens and tees.

Although bermudagrass is most commonly damaged by feeding, mechanical damage from tunneling can occur in any managed turf where appearance or playing surface is of critical importance.

Symptoms of damage:

Small and large tunnels produced by nymphs and adults

The disappearance of grass and a spongy feel under foot

A tilled appearance where larger nymphs have been actively tunneling

Pecking or digging in turf by birds and mammals

Timing of damage:

Visible damage begins to appear in mid to late July and gets progressively worse until the onset of cold weather

Damage from large nymphs and adults begins in early spring as soil temperatures rise.

Damage in spring is usually less severe than that occurring the proceeding summer and fall.

Insects that look similar; Pests that cause similar damage:

Areas with a serious grub infestation may have a similar appearance and a spongy feeling under foot at about the same time as mole cricket damage appears. However, grub infestations are much more common in cool-season grass and much less common in warm season turf. Mole cricket damage mainly limited to sandy soils and warm season turfgrass.

• Some surface-dwelling crickets look similar, but are much darker in coloration and do not have large front feet modified for digging.

MONITORING TECHNIQUES:

Soap flush for nymphs and adults is the most useful of the monitoring technique for mole crickets. Begin weekly soap flushes in the springtime in mid-June and continue monitoring to confirm the presence, distribution and size of the nymphs, and to

determine the effectiveness of insecticide applications. Mapping of the infestation based on damage noted the previous season is highly recommended to facilitate scouting and determine where treatments are required. Treatments should be applied before new damage occurs. Preventive treatments should be applied prior to egg-hatch (Early June) or at the time of peak hatch (last week of June, first week of July.

THRESHOLDS:

There are no hard and fast thresholds for this pest. Some fairways can tolerate moderate infestations, especially of the SMC. Any damage to greens and tees is more serious, and little damage can be tolerated in these areas.

MANAGEMENT STRATEGIES:

Mapping of previously damaged areas is highly recommended to facilitate scouting and determine where insecticide treatments are required. Always consult the most recent version of all product labels before use.

Follow resistance management guidelines by rotating products as outlined in IPM Template Reference "Insecticide Resistance Management Groups."

Mole cricket management strategies				
TYPE	TIMING/ THRESHOLD	PRACTICE		COMMENTS
Cultural	N/A	• Map infestations when damage is evident in fall and spring • Determine when nymphs are hatching using soapy water flush		
Biological	Apply when adult stage is detected by damage or with soap flush	Beneficial nematode products based on *Steinernema scapterisci*. For current suppliers, see http://www.oardc.ohiostate.edu/nematodes/nematode_suppliers.htm		• Pre and post application irrigation critical • Not recommended for heavy infestations
Chemical	Preventative: apply when 1st small larvae are detected with soap flush	**Active Ingredient (Product)**	**Label signal word**	• Early treatments applied to and around previously damaged areas may be sufficient to control infestation • Apply while nymphs are less than ¼ inch long
		Bifenthrin (Talstar)	Caution	
		Cyfluthrin (Tempo)	Caution	
		Deltamethrin (Deltagard)	Caution	
		Fipronil (TopChoice)	Caution	
		Imidacloprid (Merit)	Caution	
		Lambda cyhalothrin (Scimitar)	Caution	
	Curative: apply when damage first detected	Acephate (Orthene)	Caution	• Water before application. Do not water in • Avoid rain or irrigation for 24 hrs after application
		Mole cricket bait (several active ingredients)	Caution	
			Caution	

IPM Monitoring: Soap flush

Black cutworm larvae emerging from thatch following a soap flush

USES

Detects the following pests:

Black cutworm larvae

Sod webworm larvae

Black turfgrass ataenius adults

Billbug adults

Earthworms

Armyworms

NOTE: This method will NOT detect white grubs (chafers, black turfgrass ataenius, Japanese beetle, etc) and will NOT detect the larvae (grubs) of billbugs

PROCEDURE:

To prepare a soap solution, there are two approaches: for monitoring of small areas, using the watering can solution (#1 below). For monitoring of larger or multiple areas, consider use of the hose-end sprayer method (#2 below).

- Beginning in late Spring, when average air temperatures begin to exceed 55F (13C), keep an eye out for signs of caterpillars: feeding holes (Figure 3), bird activity, or dew trails (by walking over the surface of the turf at night and early morning, cutworms make a visible trail when there is dew). Use signs of early cutworm damage as a trigger date for beginning your caterpillar sampling program. Continue monitoring throughout the spring and summer, until average air temperatures begin to cool off, dropping below 55F (13C).

Purchase liquid dishwashing soap such as Lemon Joy, Ivory Clear or Ultra Dawn. These have been shown to cause the least damage to turf. Avoid Palmolive liquid dishwashing soap, as this sometimes may cause damage to turf.

Prepare a solution according to #1 (watering can method) or #2 (hose-end sprayer method) below.

Apply soap solution (using either a water can, Figure 1, or hose-end sprayer, Figure 2) to an area 1 square yard (91^2 cm). A sampling square with these dimensions can easily be assembled from PVC pipe (see Figure 1).

1) Watering can method: For use when monitoring small areas

- Add 1 oz (two tablespoons) of liquid dishwashing soap to 2 gallons of water (30 ml soap per 7.6 liters of water)
- Apply to a one square yard area, as shown in Figure 1. The turf and thatch should be well drenched with the soap solution until some suds begin to appear.

Cutworm and armyworm larvae and black turfgrass ataenius adults will surface within 10 minutes. Sod webworm larvae may take up to 15 minutes to surface.

2) Hose end sprayer method

- Prepare at least one gallon of a solution that contains two parts water to 1 part dishwashing liquid. If you plan to prepare one gallon of solution, you would need 86 oz (2.6 liters) of water and 42 oz (1.3 liters) of dishwashing liquid. It is necessary to dilute the dishwashing liquid in this way BEFORE adding it to a hose-end sprayer because it is too thick for spraying and mixing in its unaltered state.
- Obtain a hose-end sprayer such as the Gilmour Insecticide and Fertilizer sprayer (Figure 2). When using the 2:1 solution of Lemon Joy described above, set the dial of the Gilmour sprayer to 1 tablespoon.
- Apply to a one square yard area, as shown in Figure 2. The turf and thatch should be well drenched with the soap solution until some suds begin to appear.

Cutworm and armyworm larvae and black turfgrass ataenius adults will surface within 10 minutes. Sod webworm larvae may take up to 15 minutes to surface.

WARNING: Soap solution can damage turf if used at rates higher than specified above

Figure 1. Application of soap solution with a watering can. PVC pipe was used to construct this sampling square.

Figure 2. Application of soap solution with a hose-end sprayer.

Insecticide resistance management groups.

Current resistance management strategies rely on rotation among different pesticide groups. Insecticide RAC (www.plantprotection.org/irac/).

ACTIVE INGREDIENT	TRADE NAME	INSECTICIDE GROUP NAME	GROUP #
acephate	Orthene	acetyl choline esterase inhibitors	1
carbaryl	Sevin	acetyl choline esterase inhibitors	1
chlorpyrifos	Dursban, Pageant	acetyl choline esterase inhibitors	1
trichlorfon	Dylox, Proxol	acetyl choline esterase inhibitors	1
fipronil	Chipco Choice	GABA-gated chloride channel antagonists	2
bifenthrin	Talstar	sodium channel modulators	3
cyfluthrin	Tempo	sodium channel modulators	3
deltamethrin	Deltagard	sodium channel modulators	3
λ cyhalothrin	Scimitar	sodium channel modulators	3
clothianidin	Arena	acetyl chlorine receptor antagonists	4
imidacloprid	Merit	acetyl chlorine receptor antagonists	4
thiamethoxam	Meridian	acetyl chlorine receptor antagonists	4
spinosad	Conserve	acetyl chlorine receptor modulators	5
halofenozide	Mach 2	ecdysone agonist/disruptor	18

INSECT REFERENCE

Selected Insecticide Active Ingredients and the Insects they Control. Contact (foliar) products are printed in green; and systemic (soil) insecticides in red. P = preventive control; C = curative control; P/C = both preventive and curative control. Always read the most recent version of product labels to insure compliance with all use instructions.

	STAGE		INSECTICIDE ACTIVE INGREDIENT													
INSECT PEST	Larvae	Adults	Acephate	Abamectin	Bifenthrin	Carbaryl	Cyfluthrin	λ cyhalothrin	Chlorpyrifos	Deltamethrin	Fipronil	Halofenozide	Hydramethylnon	Imidacloprid	Spinosad	Trichlorfon
CONTROL TARGET = ROOTS (SOIL) OR INSIDE PLANT																
Annual bluegrass weevil	X											P		P		
Billbugs	X											P		P		
Mole crickets	X	X	C		C		C	C		C	P/C			P/C		
White grubs, including:	X		P/C			C*						P		P		P/C
• Asiatic garden beetle****	X		P/C			C*						P				P/C
• Black turfgrass ataenius	X		P/C			C*						P/C		P/C		P/C
• European chafer	X		P/C			C*						P**		P**		P/C
• Green June beetle***	X		P/C			C*						P		P		P/C
• Japanese beetle	X		P/C			C*						P		P		P/C
• Masked chafers	X		P/C			C*						P		P		P/C
• May and June beetles	X		P/C			C*						P		P		P/C
• Oriental beetle	X		P/C			C*						P**		P**		P/C
CONTROL TARGET = FOLIAGE or SOIL SURFACE																
Ants (turfgrass, nuisance)		X	C		C	C	C	C	C	C	C					
Annual bluegrass weevil		X			C		C	C	C	C						
Billbugs		X					C	C	C	C						
Chinch bugs	X	X	C		C	C	C	C	C	C						
Crane flies (leatherjackets)	X		C			C			C							
Cutworms and armyworms	X		C		C	C	C	C	C	C		C			C	C
Fire ants		X	C	B	C	C	C	C	C	C	C		B		C	
Mites	X	X			C		C	C	C	C						C
Sod webworms	X		C		C	C	C	C	C	C		C			C	C

***carbaryl curative activity on white grubs is fair to moderate; ** Oriental beetle & European chafer less susceptible to imidacloprid and halofenozide than other white grubs. ***Green June beetle less susceptible to halofenozide than to imidacloprid.**

Contact and systemic insecticides

CONTACT INSECTICIDES

- Best activity on insects that feed on foliage
- Less activity when insects feed on roots, inside plants
- Activity reduced by mowing, water, weather
- Apply in 1-2 ga/1000ft^2 (4 – 8 liters/100 meters^2). Do not water in
- Usually, multiple applications per season are required

ACTIVE INGREDIENT	TRADE NAME
acephate	Orthene
bifenthrin	Talstar
carbaryl	Sevin
cyfluthrin	Tempo
lambda cyhalothrin	Scimitar
chlorpyrifos	Dursban, Pageant
deltamethrin	Deltagard
fipronil**	Chipco Choice, Firestar**
hydramethylnon***	Amdro, Maxforce, Siege
spinosad	Conserve

SYSTEMIC INSECTICIDES

- Effective on insects that feed on foliage or roots
- Absorbed by plant and distributed **inside** the plant via the vascular system
- Less prone to break-down by water, weather, mowing
- Apply in 2-4 ga/1000 ft^2 (8 – 16 liters/100 meters^2) and water in
- Usually only one application per season is required

ACTIVE INGREDIENT	TRADE NAME
abamectin***	Ascend, Avid, Varsity
halofenozide	Mach 2
imidacloprid	Merit
thiamethoxam	Meridian
trichlorfon	Dylox, Proxol

**fipronil works on contact and also when ingested ***available as fire ant bait