



Destructive Turf Caterpillars in Hawaii

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The most common insect pests of turfgrasses in Hawaii are “lawn caterpillars,” the larvae of lepidopterous insects (moths and butterflies). Major pests in this group are three moths and one butterfly. The moths are the grass webworm (*Herpetogramma licarsialis* Walker), the lawn armyworm (*Spodoptera mauritia acronyctoides* Guenee), and several species of cutworm including the black cutworm (*Agrotis ipsilon* Hufnagel). The butterfly is the fiery skipper (*Hylephila phyleus* Drury). All of Hawaii’s turfgrasses are susceptible to attack by these four pests, although some of these insects prefer a particular type of turf. The grass webworm does the most damage and is therefore the most important turf pest in Hawaii, and the lawn armyworm also causes extensive injury. Serious outbreaks of damage by the black cutworm and fiery skipper occur less frequently.

The insect life cycle

All moths and butterflies have a similar four-stage life cycle. The **adult** is the familiar moth or butterfly, the reproductive stage of the life cycle. The adult insects mate and, depending on the species, the female lays **eggs** either singly over a period of several weeks or once or twice in masses of several hundred eggs. The eggs take from two to five days to hatch, depending on the species and, more importantly, on the temperature. The eggs

hatch into the stage called the **larva** or, more commonly, the caterpillar. The larva is the feeding stage of the insect that causes all of the damage to turf, and it is the primary target of a pest management program. The larva goes through several developmental stages called instars, and its size, color, and markings may change drastically. This part of the life cycle lasts for several weeks to a month or more, depending mainly on the temperature. As the last instar of the caterpillar matures, it burrows into the soil and enters the stage called the **pupa**. The pupa is torpedo-shaped and, in moths, is surrounded by a “cocoon” of silk and debris. The pupal stage is difficult to kill with pesticides because it does not feed and is not likely to come in contact with pesticide sprays. The pupating insect will undergo developmental changes lasting for several weeks to several months, depending on the temperature, before emerging as the adult moth or butterfly. In Hawaii, the life cycles of these insects are accelerated because of consistently warm temperatures. They are capable of completing at least five or six life cycles per year.

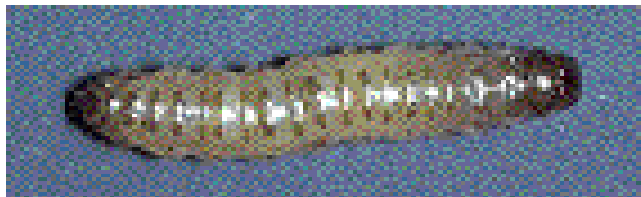
The insects can be most easily identified by the appearance of the adult moth or butterfly or the larval caterpillar. The feeding habits of the caterpillars of each species are also characteristic, and preliminary identification of the pest is often made by observing their damage.



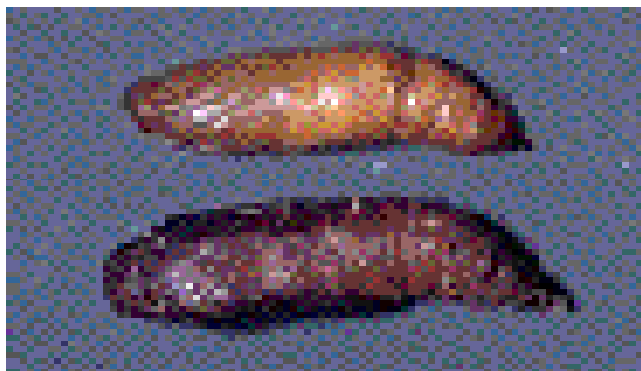
Grass webworm feeding.



Eggs of grass webworm on the upper side of a grass blade.



Grass webworm caterpillar, about 1 inch long when fully grown.



Grass webworm pupae; the lower one is a later pupal stage.

Grass webworm

The grass webworm, the major turf pest in Hawaii, is thought to have come from Southeast Asia. It was first found on Oahu in 1967 and has spread to all of the major islands. It prefers bermudagrass lawns and kikuyu-grass pastures but has 13 other host grasses including centipedegrass and St. Augustinegrass. Grass webworm feeding injury spreads more rapidly on fine textured grasses than coarse textured ones. Common bermudagrass and 'Tifway' bermudagrass are more resistant to its infestation than the other host turfs. The grass webworm is not a serious problem on zoysiagrass lawns in Hawaii.

Its eggs are laid in small groups on the upper surface of leaves and stems, along the midrib near the base of the blade. They are flat and elliptical and are laid singly or in masses overlapping each other like shingles. Just before hatching, the black head of the larva is visible through the eggshell. Egg development ranges from

4 to 6 days, and hatching takes place at night. Grass webworm eggs have been collected on grasses up to 4000 feet in elevation.

The grass webworm caterpillar develops through five larval instars. The newly hatched first instar is about $\frac{1}{16}$ inch long, translucent with a black head capsule. It is amber colored until feeding begins, when it changes to light green as a result of the ingested plant material. The other four instars have darker brown head capsules, and pairs of small dark brown spots extend along the back of the body. When fully grown, the grass webworm is slender and about 1 inch long.

The first and second instar caterpillars begin to feed on upper leaf surfaces, leaving the lower surface intact. Their initial feeding produces grass blades with ragged edges, the first visible sign of grass webworm infestation. The third, fourth, and fifth instar caterpillars notch leaf edges, eat entire leaves, and spin large quantities of



Two views of the adult, moth stage of the grass webworm; both views are about twice life size.

silk webbing. Feeding in these later instars occurs on stems, leaves, and crowns, extending to ground level and resulting in irregular brown patches in the turf. The caterpillars can be found at the edges of the feeding area, and they leave characteristic webbing and fecal pellets throughout the area. All stages feed at night and hide curled up in thread-lined tunnels in the turf thatch during the day. When disturbed, the caterpillar becomes active and rapidly moves away.

These caterpillars prefer sunny areas and are often found on south-facing or steep slopes where conditions are hot and dry. The damage caused by the webworm is often mistaken for drought stress, and the resulting turf thinning is often accompanied by weed infestation. The caterpillar reaches maturity in about 14 days.

Prior to pupation, the fifth instar larva becomes quiescent and slightly shorter in length, and it burrows into the soil to form a reddish-brown pupae about $\frac{1}{2}$ inch

long. Pupation and development usually take 6–7 days before the adult moth emerges.

The grass webworm moth has a wingspan of about $\frac{3}{4}$ inch when at rest with its wings spread in a triangular shape. The body is approximately $\frac{1}{2}$ inch long and varies from uniformly light to dark brown, with small black dots scattered over the wings. The moths are gregarious and often are found clustered on vegetation. They are attracted to light and may be a nuisance around the home when their populations are high. They are active at night and rest during the day, when they often can be found on flat surfaces in or near grass areas. The moth emerges from the pupal stage at night, and mating generally occurs that first night. Three to six days after mating, the female lays from 250 to 500 eggs over a period of five to seven nights. The adult moth has a life span of about 13 days.



Eggs of the lawn armyworm: egg mass (left) and numerous emerging first-instar caterpillars (right).

Lawn armyworm

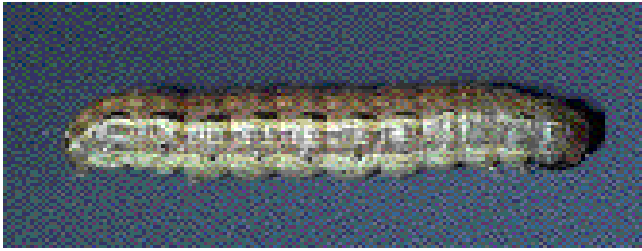
The lawn armyworm is a native of Southeast Asia, Indo-Australia, and the South Pacific. It was first recorded on Oahu in 1953 but apparently arrived well before that time. It is now found on all major Hawaiian islands. Hawaii's particular species of armyworm is apparently not found anywhere else in the USA. During the 1960s it was considered Hawaii's most severe lawn pest, but recently its populations have stabilized, possibly held in check by various parasites and predators.

In Hawaii the lawn armyworm is a serious problem mainly on bermudagrass lawns, but it will also feed on sedges, sugarcane seedlings, seashore paspalum, and zoysiagrass. Severe damage to lawns is characterized by a completely denuded circular area sharply defined by a front of undamaged turf. With heavy populations of actively feeding larvae, this destruction may advance

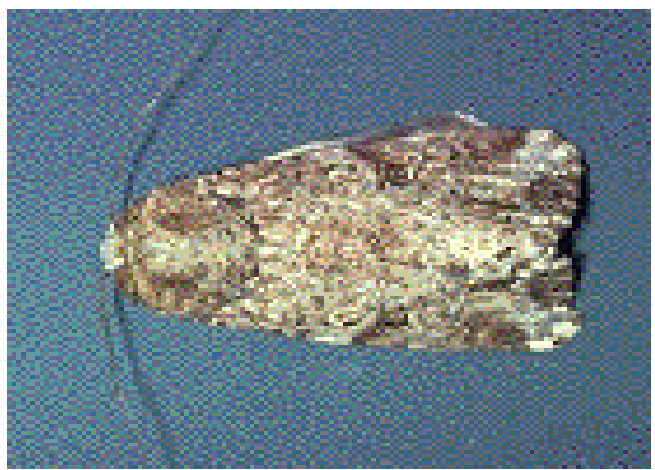
about 1 foot each night.

The eggs are laid in masses of 600–700 eggs that are covered with long, light brown hairs from the abdomen of the female. These felt-like egg masses are cemented to leaves of trees and shrubs or on buildings close to lights. They are often found on eaves and open lanai ceilings. Brushing the egg masses off helps to physically control the insect. The eggs hatch in three to five days.

The larva of the lawn armyworm has seven to eight instars. The first instar upon hatching is a tiny, green caterpillar about $\frac{1}{16}$ inch long, which spins a silken thread to reach the ground and begin feeding on grass blades. The caterpillars tend to remain in the same area and feed together, forming the characteristic steadily increasing circle of destruction. Close examination of armyworm-



Two views of the lawn armyworm caterpillar (life size is about 1½ inches); the one at right in its later-stage coloration.



Two views of the moth (adult) stage of the lawn armyworm, about twice life size; wings open (left) and wings folded (right).

infested stands of turf will reveal clipped or skeletonized grass blades mingled with green fecal pellets. Larvae will be found feeding near the edges of the damaged area. Occasionally, large numbers of armyworms will develop in one area, then migrate to another after exhausting their food supply.

As they grow, the caterpillars become brownish, with a pair of pale stripes down the length of their backs. They reach a mature length of approximately 1½ inches in about 28 days. The young caterpillars feed on the grass during the night and day, but older and larger ones feed only at night and hide in the thatch during the day. When disturbed, the caterpillars will become active and jump around rapidly.

The mature final-instar caterpillar burrows into the soil and forms a hardened, reddish-brown casing (pupa)

around itself. The average length of the pupa is ⅝ inch. The caterpillar pupates in the soil and emerges as an adult moth in 10–14 days. The total life cycle can be completed in about 43 days in Hawaii, with about 8 generations per year.

The adult lawn armyworm is a grayish-brown, thick-bodied moth with a wingspread of about 1½ inches. The forewings are marked with several dark lines and a conspicuous black spot. The moth emerges from the pupa and mates within one day. The female begins laying eggs about four days later. The adult moth lives for about 12 days. The females fly at night and are attracted to lights, often laying their eggs near one. Populations of lawn armyworms may be locally controlled by reducing night lighting adjacent to sensitive turf areas or by using yellow light bulbs, which are less attractive to the moth.



The variegated cutworm caterpillar is similar in size and appearance to the black cutworm; actual size is 1½–2 inches long.



Moth stage of the variegated cutworm.

Cutworms

Cutworms, including the black cutworm or some closely related species, are found in practically every part of the world. “Cutworm” is the common term for the larval stage (caterpillar) of various moths of the genus *Agrotis* and other related genera of the family Noctuidae. They feed on many plants including trees, turfgrass, rice and other cereals, and the seedlings of tomato and crucifers, cutting off stems, buds, and young leaves. They feed at night and burrow into the soil during the day.

Black cutworm eggs are laid singly or in small clusters. The female prefers to deposit her eggs on curly dock and mustard plants. One method of control of black cutworm is to eliminate or reduce these broadleaf weeds. The eggs hatch in 3–6 days.

The larva is brownish on top with a broad, pale gray band along the midline. It has gray-green sides with lateral, blackish stripes. The head capsule is brownish-black with two white spots. The mature instar is a plump, blackish caterpillar 1½–2 inches long. The caterpillars remain in shallow holes during the day and curl up when disturbed. They emerge at night to feed on grass blades and stems of young seedlings, shearing them off at ground level. The feeding causes browning in turf. Cutworms are solitary feeders, and their infestations are usually in much smaller numbers than infestations of lawn armyworms or grass webworms, and cutworm damage, therefore, is usually not as serious. However, a small population of black cutworms can devastate a



The moth caterpillars compared

Actual-size comparison of caterpillars of the black cutworm (top), lawn armyworm (middle), and grass webworm (bottom). These late instars are approaching full size. The ruler is in millimeters; the bar is 1 inch long.

newly emerged bed of flower or vegetable seedlings in a very short time.

The caterpillar lives for 28–34 days before boring into the soil to form the pupa, which is dark brown and about $\frac{3}{4}$ inch long with a posterior spine. The pupal stage lasts 10–14 days before the adult moth emerges.

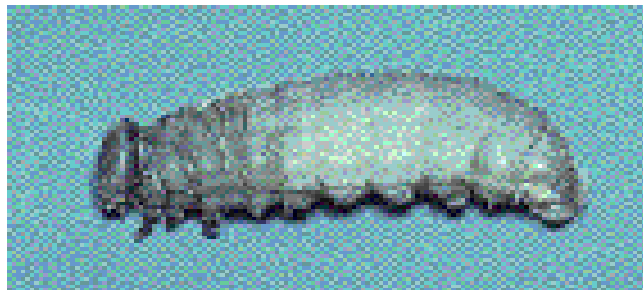
Black cutworm adults are large, thick-bodied, nocturnal moths with a wingspan of $1\frac{1}{2}$ –2 inches. The body is gray and the forewings are gray with dark brownish-black markings. The hindwings are almost all white but have a dark fringe. The moths mate within two to four days after emergence. The female lays 1200–1600 eggs, singly or a few together, over a 5–10 day period. The adult moths may live for up to 30 days.



Lawn damage from the fiery skipper.



The fiery skipper lays its eggs singly on a blade of grass.



The fiery skipper caterpillar has a prominent head due to its narrow neck.

Fiery skipper

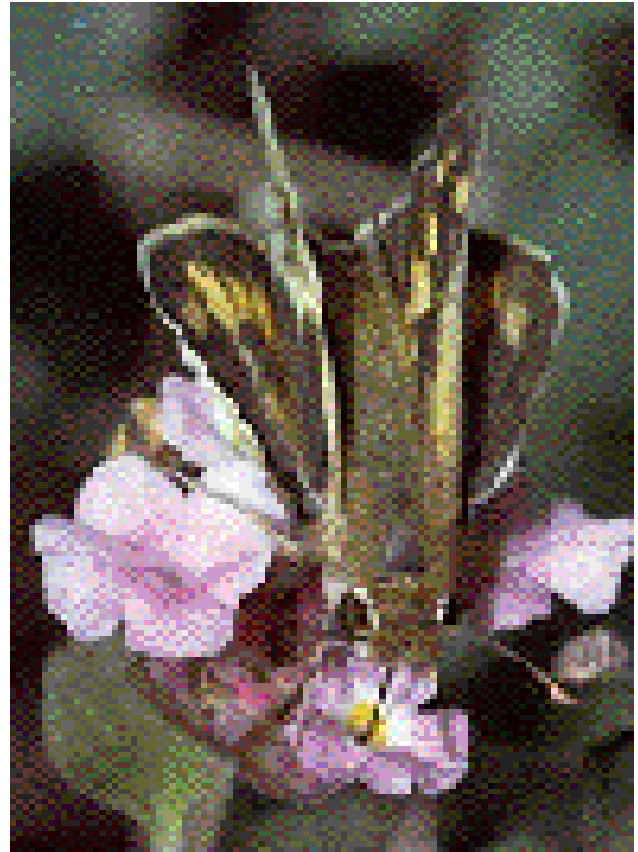
The fiery skipper is a butterfly that is active during the day and is almost always found in open lawns, gardens, and fields in populated suburbs rather than in undisturbed rural areas. This butterfly has the rapid, skipping flight common in the insect family Hesperiiidae. The fiery skipper caterpillar prefers bermudagrasses. The larvae develop more slowly on zoysiagrasses and centipedegrass and are seldom seen on St. Augustinegrass.

Fiery skipper eggs are laid singly on the undersurface of grass leaves and stems. They hatch 2–3 days after being laid.

The larva has distinctive, reddish markings on the front of its oversized, black head. It has a narrow neck, followed by a dark thoracic shield and a greenish-pink body with a granulated texture. The caterpillars spin silk shelters in the thatch and are not readily seen unless flushed out by a pyrethrin or detergent test. The average length of time to complete the larval stage is approximately 16 days. Fiery skipper damage in turf is a 1–2-inch round spot from which all the grass has been eaten by a single larva. If there is a large population, these spots will combine into larger dead patches. Damage



This fiery skipper pupa is surrounded by thatch debris.



The fiery skipper butterfly is found mostly in open suburban or urban landscapes.

usually appears on turf located near flowerbeds, where the adult skippers feed.

The mature fiery skipper caterpillar burrows into the soil to form a pupa that is light yellow but otherwise similar in appearance to the pupa of the grass webworm or the black cutworm. The adult butterfly emerges in 7–10 days.

The adult has a wingspan of 1¼–1½ inch. The wings are orange-brown. The outer margins of the male's wings are black and toothed above, the forewing has a wide black stigma, and the underside of the hindwing is scat-

tered with small black spots. The upper side of the female is dark brown with a very irregular orange band, and the underside of the hindwing is pale brown with paler checks. Skippers are distinguished from other butterflies by having a hooked knob at the end of their very short antennae. The adult butterflies are strongly attracted to nectar-producing flowers, such as lantana. The males pursue the newly emerged females, and mating takes place within a day. Three to four days later, the female begins laying 50–150 singly spaced eggs.

Control measures

Insecticide application is usually the first line of defense when there is a sudden, widespread increase of defoliation by a turfgrass pest. There are few alternatives but to depend upon a recommended chemical or biological insecticide. Numerous insecticides for application to turfgrasses have been registered with the EPA and the Hawaii Department of Agriculture for use in Hawaii (Table 1, pp. 12–13). Pesticide registrations are constantly changing and are often different from state to state. Always read the label before applying a pesticide to be sure that the intended use is stated on it.

Before taking any control measures, identify the pest that is present and estimate how many caterpillars are feeding in a given area. If caterpillars are not readily seen, flush them out with soapy water or a solution of pyrethrin insecticide poured over the area where activity is suspected. Use 1–2 oz of dish soap or ½ oz of a pyrethrin-containing insecticide in about 2 gallons of water. Soak an area of about 1 square yard with the mixture and wait for a few minutes. The caterpillars will be irritated by the solution and come to the surface. Collect the caterpillars in a can and count them after you are sure there are no more hidden in the thatch (after 10 minutes). Repeat the test in other areas where infestation is suspected. Depending on the caterpillar species and the population density, treatment with insecticide may or may not be necessary. Spot treatments in severely affected areas may be the best approach, or a much larger treatment may be necessary if the test indicates that the entire lawn is heavily infested. Treatment is recommended if flushing of 1 square yard of turf reveals more than five or six caterpillars of black cutworm or lawn armyworm and more than 15 caterpillars of grass webworm or fiery skipper. These threshold levels are a general recommendation. Some experts believe that only four or five caterpillars of the grass webworm are enough to warrant treatment. Even one larva may be unacceptable in a highly manicured golf green.

Proper timing of a pesticide application to direct it against the most vulnerable stage of the turfgrass pest is necessary for effective control and usually reduces the number of applications needed for complete control. All four of Hawaii's major turfgrass pests described here are destructive to turf only during the larval (caterpillar) stage. All of these pests are more easily controlled

in the younger caterpillar stages (the first few instars). They become much more difficult to eradicate as they near pupation, and they are resistant to pesticide treatment in the pupa stage.

Pesticide application techniques

Before applying an insecticide, the turf should be mowed and the clippings removed to enhance pesticide penetration into the turf canopy. A thorough irrigation before application moves insects out of the thatch and soil and brings them to the surface. For night-feeding larvae (grass webworm, lawn armyworm, black cutworm), apply the insecticide in the late afternoon or early evening. Light irrigation after spraying rinses the insecticide off grass blades and into the turf where thatch-active caterpillars reside. A heavier irrigation should follow granular insecticide applications to wash the granules into the thatch and activate the insecticide. After this initial post-application irrigation, do not irrigate again or mow for at least 24 hours. Some biological control agents and newer chemical pesticides may require special handling and application techniques. Always read and follow the pesticide label instructions.

Liquid pesticide formulations are mixed with water and sprayed on the grass. If a compressed-air sprayer is used, mix the recommended amount of pesticide with 3 gallons of water for every 1000 square feet (sq ft, or ft²) to be treated. If a watering can is used, mix the recommended amount of insecticide with 12 gallons of water for every 1000 ft². If using a hose-end sprayer, put the recommended amount in the jar and follow the directions for the particular model of sprayer. Wettable powder formulations are mixed in the same manner but the solution must be shaken frequently during application. Granular formulations should be applied with a mechanical spreader and watered in well. Apply these insecticides only to the lawn area, avoiding all other plants or ornamentals. Observe and follow label directions for reentry to treated areas. Allow several days for the full effect of the treatment to take place.

Types of insecticides

Systemic insecticides are absorbed and translocated through the plant. They may be applied as a liquid spray or root drench or granular soil application. Foliar spray

applications usually result in poor systemic activity. Systemic insecticides usually have a long-lasting residual effect. The usual mode of action for this type of insecticide is by affecting the nervous system of the insect after it is ingested when plant sap is sucked or leaves are eaten.

Contact insecticides are not absorbed by the plant and are effective only if they make direct contact with the insect, or if the insect eats the treated leaves or comes into contact with the residue before the insecticide is washed off by rain or overhead irrigation. Many of these insecticides contain additives (“stickers”) that improve adherence to the plant and provide a certain amount of resistance to being washed off. However, contact insecticides are usually not as long lasting as systemic types. A contact insecticide is usually applied as a foliar spray and affects the nervous system of the insect upon direct contact or ingestion.

Insecticides sometimes damage plants due to phytotoxicity. It is advisable to test any product on a small scale before making large-scale applications. Spray according to label directions, and spray again a week later (unless the label prohibits such a frequency). Allow 5–7 days for symptoms to appear; for systemic insecticides, allow 14–21 days for symptoms to appear.

Insect growth regulators (IGRs) are normally applied in a foliar spray. Some may have a limited absorption and translocation in the plant and therefore exhibit a local systemic type of action. Others enter the insect by contact. The mode of action for IGRs is by interference with the metamorphosis and adult development of the insect.

Microbial control options in Hawaii are limited. One that is commercially available is a species of bacterium (*Bacillus thuringiensis*, “Bt”) which produces an endotoxin that is ingested by insects.

Another type of microbial agent is insect-parasitic nematodes. These soil-inhabiting, microscopic roundworms parasitize caterpillars and certain other insects, reproduce inside of them, and then emerge to reinfect other hosts. Insect-parasitic nematodes thrive only in moist environments where they will not dry out. They are therefore effective against soil and boring insect pests including cutworms, armyworms, webworms, wireworms, and caterpillars occurring in moist, humid mi-

croenvironments. Nematodes are not effective against foliar feeding (sucking or chewing) insects. Several species of insect-parasitic nematode are in agricultural use. *Steinernema carpocapsae* has recently been conditionally approved for use as a microbial control agent in Hawaii, and it may soon be commercially available.

Other naturally occurring microbial control agents include pathogenic bacteria, fungi, and viruses that attack the caterpillars.

Cultural control

Remove heavy thatch to eliminate much of the daytime resting habitat for the nocturnal larvae. However, the grass webworm can be present in large numbers without much thatch cover. Do not promote thatch buildup with heavy nitrogen fertilization or excessive watering. Core aerating the soil followed by top-dressing with organic matter also helps prevent thatch build-up. Avoid stressing turfgrasses by overmowing or underwatering. The lawn armyworm tends to lay eggs in damp areas with rank growth, so eliminating such areas helps control this pest.

Biological control

The four turf pests described here have numerous other natural enemies in Hawaii, including parasites and predators. Parasites include a trichogrammatid wasp, which attacks the eggs, and paper wasps (vespids) and mud dauber wasps (sphecids), which feed their young by stinging caterpillars, then stocking their nest with the paralyzed caterpillars to serve as future food for the newly emerged young wasps. Ichneumonid, braconid, and chalcid wasps are also common parasites of caterpillars in Hawaii.

A long list of predators includes several species of ants, carabid beetles, the giant bufo toad, and many species of birds including the common mynah bird, cattle egret, Brazilian cardinal, and golden plover, all of which feed on the caterpillars and the adult moths and butterflies. Often these control agents naturally occur in sufficient numbers to effectively keep populations of turf insect pests under control.

Some common insecticides labeled for use in Hawaii that are effective against turf caterpillars

The insecticides listed are effective against the larval (caterpillar) stages of the insects and are most effective when applied early in the development of the larval instars before damage from their feeding becomes too severe.

The accuracy and completeness of this information is not warranted. The products mentioned as examples were licensed for sale in Hawaii as of January, 2000. Pesticide registrations and allowed uses frequently change. Pesticide users should read the product label to be sure that the intended use (target pest and site of application) is included on it, and follow all label directions, precautions, and restrictions. If label information differs from that provided here, follow the label. Listing of products is for information purposes only and should not be considered a recommendation.

Caution: insecticides may damage certain plants; make a test application on a small area before large-scale application (see p. 11).

*An asterisk by a pesticide name indicates that it is a Restricted-Use Pesticide (RUP) that can be purchased and applied only by people with appropriate certification from the Hawaii Department of Agriculture.

†Indicates toxicity to fish and aquatic organisms.

Chemical control agents

Active ingredient	Chemical class	Example product name	Comments
spinosad	spinosyns	Conserve SC	Turfgrasses; check label for other registered application sites. Contact poison. May cause phytotoxicity. Recommended for IPM programs; does not significantly impact the natural predaceous arthropods including ladybird beetles, lacewings, minute pirate bugs, and predatory mites.
bifenthrin	synthetic pyrethroid	Talstar® GC Flowable	Turfgrasses; check label for other registered application sites. Contact poison. Some products for use by commercial applicators only.
cyfluthrin	synthetic pyrethroid	Tempo® 20 WP * †	Turfgrasses; check label for other registered application sites. For use by commercial applicators only. Cyfluthrin is a contact poison that is fast to intermediate acting, effective within 1–7 days; residual effect lasts 3–6 weeks.
lambda-cyhalothrin	synthetic pyrethroid	Scimitar® GC * †	Turfgrasses; check label for other registered application sites. Contact poison. For use by commercial applicators only.
deltamethrin	synthetic pyrethroid	DeltaGuard® GC * †	Turfgrasses; check label for other registered application sites. Contact poison. For use by commercial applicators only.
acephate	organo-phosphate	Orthene®	Turfgrasses; check label for other registered application sites. Systemic and contact poison. Odorous, fast acting, effective within 1–3 days, residual effect lasts 1–2 weeks.
chlorpyrifos	organo-phosphate	Dursban® 50W *	Turfgrasses; check label for other registered application sites. Contact poison. Odorous, intermediate acting, effective within 3–7 days, residual effect lasts 3–6 weeks. Many products for use by commercial applicators only. May be fatal if swallowed or absorbed through skin.
diazinon	organo-phosphate	Diazinon 4E * †	Turfgrasses; check label for other registered application sites. Contact poison, fast acting, effective within 1–3 days, residual effect lasts 1–2 weeks. Not for use on golf courses and sod farms. Some formulations for use by commercial applicators only.
halfenozide	insect growth regulator (IGR)	Mach 2™	Turfgrasses; check label for other registered application sites. Systemic insect growth regulator that acts as a molt-accelerating compound (MAC).

Chemical control agents (continued)

Active ingredient	Chemical class	Example product name	Comments
imidacloprid	chloronicotinyl	Merit® 75 WP	Turfgrasses; check label for other registered application sites. Contact and systemic poison. Applied as foliar spray or soil drench.
carbaryl	carbamate	Sevin® *	Turfgrasses; check label for other registered application sites. Contact poison. Intermediate-acting, effective within 3–7 days, residual effect lasts 3–6 weeks. Some formulations for use by commercial applicators only.

Microbial control agents

Organism	Product name	Comments
<i>Bacillus thuringiensis</i> (Bt) (bacterium)	DiPel® 2X	Turfgrasses; check label for other registered application sites. Insect stomach poison (through production of spores and endotoxins). Only effective on early-instar larvae; repeat applications may be necessary. Breaks down rapidly in sunlight and washes readily off leaves.

Biological control agents

Organism	Product name	Comments
<i>Steinernema carpocapsae</i> (nematode)	Millenium Biological Insect Control	Turfgrasses; check label for other registered application sites. An insect parasite recently labeled for use in Hawaii.

Mention of a trademark, company, or proprietary name does not constitute an endorsement, guarantee, or warranty by the University of Hawaii Cooperative Extension Service or its employees and does not imply recommendation to the exclusion of other suitable products or companies. Caution: Pesticide use is governed by state and federal regulations. Read the pesticide label to ensure that the intended use is included on it, and follow all label directions.

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