Irrigated Alfalfa Management
for Mediterranean and Desert Zones



# Managing Insects in Alfalfa

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**Chapter 9**

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Over 1,000 species of arthropods have been observed in alfalfa fields. Of these, fewer than 20 cause injury, and fewer still are serious pests. The number of phytophagous (plant-eating) species is far exceeded by the number of non-plant feeders, and many of the latter are predators or parasites. Alfalfa has been called "the insectary of the Central Valley" since it is home to many predators and parasites that move among crops and provide biological control of pests in diverse cropping systems, as well as in alfalfa.

Although only a few pest species infest alfalfa, they can cause substantial yield and quality losses if present in high numbers. Some pests, such as the Egyptian alfalfa weevil (*Hypera brunneipennis* Boheman), routinely cause damage annually in established alfalfa. Most pests, however, tend to be more sporadic, causing yield losses on a less frequent basis. An effective pest management program can significantly reduce the losses caused by these pests. To implement an Integrated Pest Management (IPM) strategy to optimize economic returns in alfalfa, the following principles must be observed:

- correct identification of pest and natural enemy species
- use of economic threshold values, including natural enemy activity
- careful monitoring and sampling of pest and natural enemy populations
- implementation of control strategies that minimize effects to natural enemies and other nontarget species

## Insect Identification

Proper identification of pest and natural enemy species cannot be overemphasized. Many insect species, particularly in the immature stages, are similar in appearance and may easily be mistaken for each other. For example, lygus bug (*Lygus* spp.) nymphs, which feed in alfalfa, may be confused with big-eyed bug (*Geocoris* spp.) nymphs, a natural enemy that helps control insect pests. Pea aphids (*Acyrthosiphon pisum* Harris) and blue alfalfa aphids (*A. kondoi* Shinji) are similar in appearance and can easily be misidentified. Since their economic thresholds differ, improper identification can lead to improper management decisions. Failure to properly identify natural enemy species may lead to unnecessary pesticide applications if predator or parasite populations are sufficient to maintain pest numbers below economic thresholds. A series of color photos of pests and natural enemies can be found at the end of this chapter (Color Plates 9.1–9.24).

## Economic Thresholds

The economic threshold is defined as the pest population at which control measures should be initiated to prevent yield or quality losses. Economic damage has been most often defined in terms of yield reduction, but forage quality must also be considered. Because many insects, such as alfalfa weevils and caterpillars, are leaf feeders, and forage quality is highest in leaves, reduction in quality may be as important as yield reduction. Aphids and leafhoppers deposit large quantities of honeydew on the leaves, resulting in the growth of sooty molds that may make the hay unmarketable or unpalatable to livestock. Some economic threshold levels, such as those for alfalfa caterpillars and some aphid species, take parasite abundance into account and thus require information on natural enemy populations as well as pest populations before informed decisions can be made.

## Monitoring and Sampling

Pest population levels can increase rapidly, from a few individuals to numbers exceeding the economic threshold in a short time. Sampling for pests and natural enemies is critical for implementing an IPM program. Insect populations vary from year to year and from field to field. Some general trends can be derived based on field histories, but examination of the insect population in each field is the only reliable way to accurately assess population levels. Keep records of pest and natural enemy numbers, along with information on weather conditions and other crop production practices used in each field. Fields should be monitored weekly during periods of pest activity (Fig. 9.1) and more often as pest numbers approach economic threshold levels.

### Standard Sweep-net Techniques

Sampling for specific insect pests is discussed in the description of each species. However, since the use of a sweep net is so universal in sampling alfalfa, both for pest and natural enemy species, this section is devoted to the proper use of this tool.

A 15-inch- (38-cm-) diameter sweep net (diameter of the hoop) with a 26-inch (66-cm) handle is the standard sampling tool used in alfalfa. The net should be swung in a 180° arc such that the net rim strikes the top 6 inches (15 cm) of alfalfa growth. The net should be held slightly at an angle, so that the bottom edge strikes the alfalfa before the top edge passes through. This facilitates gathering insects into the net. Each 180° arc is consid-

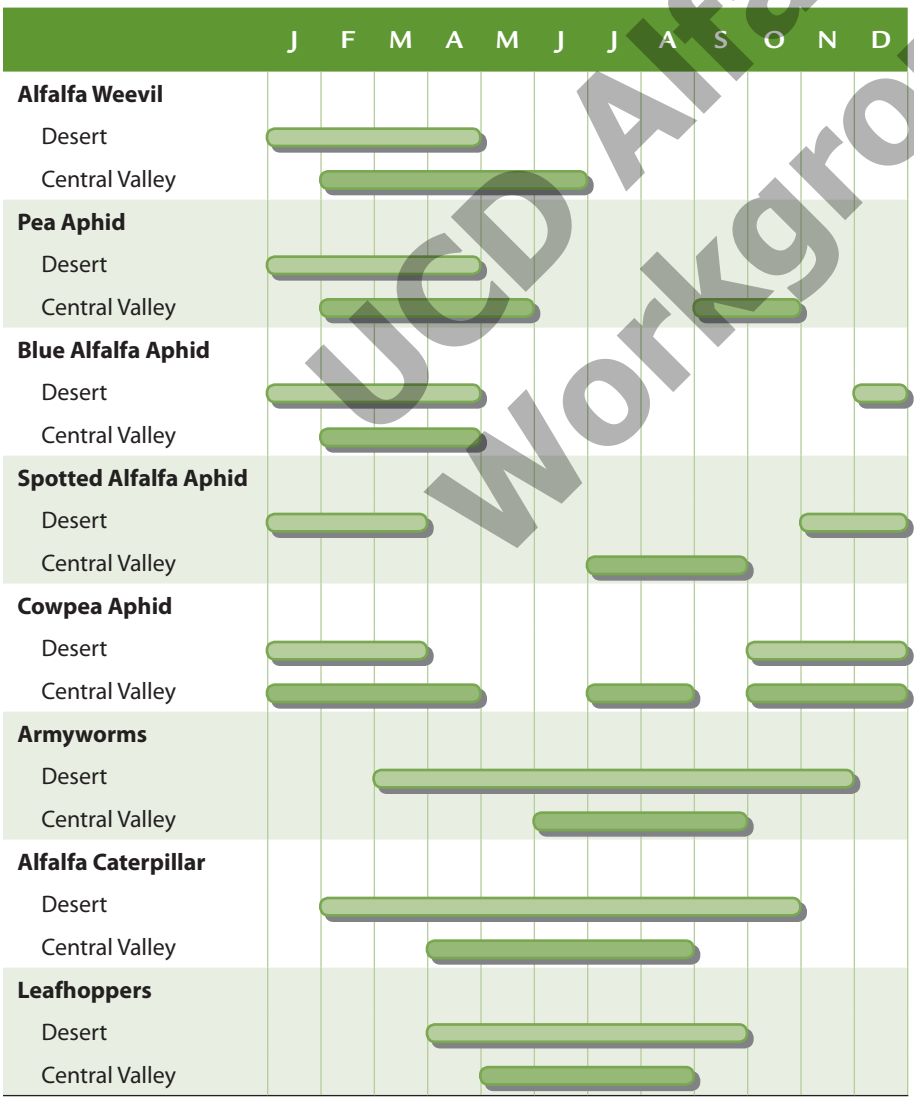
ered one sweep. Take a sweep right to left, walk a step, and take a second sweep, left to right, and so on (Fig. 9.2).

After taking the desired number of sweeps, quickly pull the net up through the air to force insects into the bottom of the net bag and grasp the net bag at about the midpoint. The net bag can then be slowly inverted while releasing the grasp on the bag to allow the insects, such as leafhoppers, to slowly escape and be counted. If large numbers are netted, or if they are slow moving, such as caterpillar larvae, the net contents can be dumped into a white enamel pan, and counts can then be made. If insect numbers are very high, place the net contents in a paper bag and return it to the laboratory or office. The sample should be chilled to slow down the movement of highly active insects. Pest management decisions, however, are generally made before such high numbers build up. Samples should be collected from all portions of the field. Nonrepresentative parts of the field, such as field edges, should be avoided. A common practice is to trace an "X" or "W" pattern within the field to be certain that a representative sample is taken. A minimum of four locations in each field should be sampled. Then, average the counts taken from all areas to determine the overall average number per sweep.



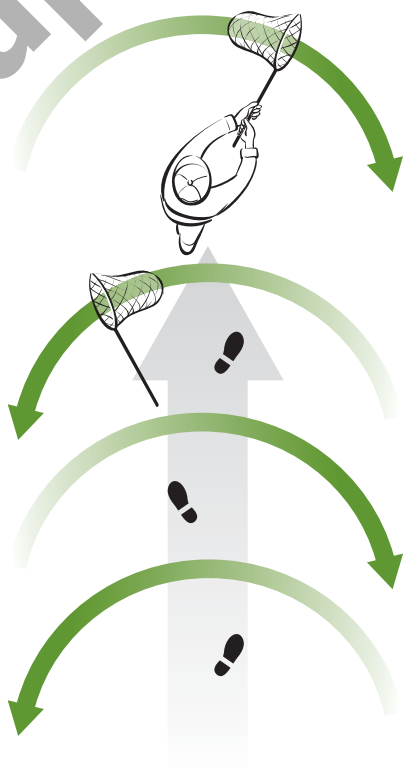
## FIGURE 9.1

Seasonal occurrence of the major alfalfa pests in the Imperial Valley and the Central Valley of California.




## FIGURE 9.2

A single sweep is one 180° arc taken as you walk through the alfalfa.



## Integrated Pest Management Strategies

Integrated pest management involves the use of all available strategies to properly manage pests. These strategies include selection of pest-resistant varieties, manipulation of cutting schedules (accelerated or delayed), habitat modification by the use of strip-border cutting, grazing, use of biological controls, and judicious use of pesticides, when required. These strategies are discussed for each pest later in this chapter.

### Resistant Varieties

Selection of pest resistant varieties is a key element in the management of several alfalfa pests. Varietal resistance is not absolute and means only that a certain percentage of the plants in the population are resistant, not all of them. For example "highly resistant" (HR) means that a minimum of 50 percent of the plants are resistant. Therefore, if pest populations are particularly high, severe damage can still result, even in highly resistant varieties. See Chapter 5 ("Choosing an Alfalfa Variety") for a complete discussion of pest resistance. Resistance is also discussed in sections on individual pests. A list of alfalfa varieties and the pests they are resistant to, including insects, diseases, and nematodes, is available from the National Alfalfa and Forage Alliance and can be accessed at http://www.alfalfa.org.

*Selection of pest resistant varieties is a key element in the management of several alfalfa pests.*

### Border-strip Harvesting

Border-strip harvesting involves leaving uncut strips of alfalfa at various intervals across the field. These border strips serve as a refuge for natural enemies and to retain lygus bugs in the alfalfa where they do little harm, and keeps them out of neighboring crops, such as cotton or beans, where they can cause significant damage. Uncut strips, 10–14 feet (3–4 m) wide, are left adjacent to every second irrigation border (or levee). An actual levee is not needed; strips can be left at approximately 150–200-foot (45–61-m) intervals across the field. At the next harvest, these strips are cut with one-half of the alfalfa strip going into one windrow, together with half the swather width containing new alfalfa (right side of the swather), and the other one-half going into a second windrow (left side of the swather). This blending of old and new alfalfa minimizes quality problems that might arise from the older hay. At this cutting, new uncut strips are then left adjacent to the alternate irrigation borders.

### Chemical Controls

Insecticides may be needed when pests reach economic threshold levels, despite the use of alternative, nonchemical control strategies. When using pesticides, it is important that the proper chemical, rate, timing, and application method be used. The selected chemical should be easy on natural enemies while maximizing control of the pest. Selection of an insecticide depends on several factors, including proper registration, effect on the pest to be controlled, pre-harvest interval, reentry interval, cost, desired length of residual control, and selectivity to natural enemies.

Since chemicals and their registrations change frequently, we will not present insecticide recommendations here. Please refer to the "UC IPM Pest Management Guidelines for Alfalfa Hay," available at http://www.ipm.ucdavis.edu/PMG/selectnewpest.alfalfa-hay.html or from your local University of California Cooperative Extension Office. These guidelines contain the latest update of

chemicals recommended for pest control in alfalfa in California. In other states, consult your county extension office. The most important thing to do when applying insecticides is to read and follow the label instructions.

Although they are important tools, insecticides have some drawbacks, which include:

**Secondary outbreaks** of pests can occur when an insecticide is applied to control a pest but inadvertently kills natural enemies. These natural enemies may have been important for controlling another insect pest, and without this natural control, the second pest builds to high enough levels to become damaging. This new pest is called a secondary pest and its rise to pest status resulted from the insecticide application.

**Pest resurgence** is another drawback from insecticide applications. Similar to a secondary outbreak, this results from the effects of nonselective insecticides on natural enemies. The insecticide initially controls the target pest but also destroys populations of natural enemies. Pest resurgence results when pest populations rebound but the natural enemy populations are delayed or develop more slowly than the pest.

**Hazards to honeybees** can be a problem with insecticides used in alfalfa. A hay crop is normally harvested before the alfalfa plants are in bloom and attractive to bees, but blooming weeds can sometimes entice bees into alfalfa fields. This is particularly true before the first cutting when blooming weeds are most common. Many tree fruits are in bloom at that time and require bees for pollination.

**Phytotoxicity (chemical injury, foliage burn) to alfalfa plants** under certain conditions can result from insecticide sprays. Environmental conditions can influence insecticide properties and the hardiness of the alfalfa plant and its susceptibility to phytotoxicity from insecticides.

**Off-site movement of insecticides** has become an increasing concern in recent years. This movement can result from aerial drift or movement through surface water and groundwater. Alfalfa has been implicated in movement of some organophosphate and, to a lesser extent, pyrethroid insecticides into surface waters. Volatile organic compounds (VOCs) are of concern as pollutants from insecticides and adjuvants. Refer to the UC IPM Web site http://ipm.ucdavis.edu/PMG/selectnewpest.alfalfa-hay.html for more information on water quality protection.

**Safety** to pesticide applicators, handlers, field scouts, and others associated with alfalfa culture is of concern. Likewise, effects on birds, mammals, and invertebrates after insecticide application represent an important consideration regarding the selection of pesticides for use in alfalfa.

**Insecticide resistance** is a concern in all crops. Insecticide resistance takes place when some insect pests survive an insecticide treatment. The survivors then pass the genes for resistance on to the next generation. The more frequent the insecticide application, the more rapidly a population develops resistance. Eventually, insecticides are rendered ineffective through this phenomenon. Resistance management is the process used to maintain susceptibility, and therefore insecticide efficacy, within a pest population. It is important for growers to reduce the number of insecticide applications to reduce the potential for resistance. Alternating insecticides with different modes of actions is another method used to maintain susceptibility. Fortunately, problems with insecticide resistance in insects attacking alfalfa hay are rare.

*It is important for growers to reduce the number of insecticide applications to reduce the potential for resistance.*

The remainder of this chapter discusses the insect pests found in alfalfa with a brief description of the insect, its biology, and its damage. We also discuss economic thresholds and techniques for monitoring and sampling, and provide management guidelines.

## Important Insect Pests—Alfalfa Weevil

Alfalfa weevil (*Hypera postica* Gyllenhal) and Egyptian alfalfa weevil (*H. brunneipennis* Boheman) are the most important insect pests of alfalfa in California (Color Plate 9.1). The two species are very similar; the appearance of the adults and larvae is identical. Separate introductions of these pests from foreign sources have resulted in the separate species designations. Research indicates, however, that the two are likely biotypes of the same species.

There are some important biological differences between the alfalfa weevil and Egyptian alfalfa weevil, the most significant being that the former dominates in cooler climates of the Intermountain Region and the Coast, while the latter flourishes in the Central and Imperial Valleys and the High Desert. Egyptian alfalfa weevil larvae encapsulate eggs of the parasite *Bathyplectes curculionis* (Thomson), whereas larvae of the alfalfa weevil do not. The management of these two pests is identical and they will be considered together.

The larval form of these weevils inflicts the majority of the damage to alfalfa (Color Plate 9.2). Early instars feed in the terminals, and larger larvae feed on the leaflets. Under severe pressure, the plants can be completely defoliated. Damage begins in spring (Fig. 9.1) and accumulates over a 4–6-week period. The larvae are legless and about 0.25 inch (0.6 cm) long when fully grown. They are pale green, a thin white line runs down the center of the back, and the head is black. They pupate in a loosely woven cocoon, either on the soil surface or attached to foliage. After 2–3 weeks of pupation, the new adult emerges. Adult weevils are dark gray and about 0.20 inch (0.5 cm) long. Adults feed on alfalfa stems for a short time, rasping the epidermis along the length of the stem. They then leave the field, seeking sites in which to spend the summer in a state of estivation (summer hibernation). These sites include areas under the loose bark of trees, especially eucalyptus, or in any place they can wedge their bodies, such as in rough-barked trees (walnut), cracks in almost any surface, or under shake shingles on homes.

In recent years, Egyptian alfalfa weevil has evolved from a univoltine (one generation per year) into a multivoltine (several generations per year) insect. Rather than leaving the field as noted above, some adults remain in the alfalfa, mate, and continue to lay eggs. These eggs soon hatch, giving rise to a second, and sometimes third, generation of weevil larvae that continue to cause damage to subsequent cuttings. After the first cutting, fields should continue to be monitored either using a sweep net or visual observation if the alfalfa is too short to sweep to be certain that no additional weevil larvae are present.

In late fall or early winter, adults that have spent the summer in aestivation emerge and return to alfalfa fields. The adults mate, and the females begin inserting their lemon-yellow eggs into alfalfa stems. Eggs usually hatch in late winter–early spring. The key period for management of alfalfa weevil and Egyptian alfalfa weevil is typically before the first cutting, although later cutting, as noted above, can also be damaged.



### Monitoring and Management Guidelines for Alfalfa Weevil

Alfalfa weevil larvae are sampled using a standard 15-inch- (38-cm-) diameter sweep net. Sampling should be conducted in at least four areas of the field and by taking five 180° sweeps per area. The economic threshold for initiating chemical control is 15–20 larvae per sweep. Control options include insecticides and early harvest. With the early harvest option, alfalfa regrowth for the second cutting should be closely monitored for feeding damage.

Biological control with generalist predators is not effective because the complex of natural enemies has not yet developed during this late winter–early spring period. Specific weevil parasites have been introduced into California but have been largely ineffective against both alfalfa weevil biotypes. An alfalfa weevil-specific fungus, in many alfalfa-growing regions of California, aids in biological control. In years of heavy rainfall, the fungus *Zoophthora phytonomi* (Arthur) infects the larvae, causing their death. Look for brown or

discolored larvae on the underside of leaves at the top of the plant. In some regions, the fungus maintains weevil populations below the economic threshold level and may help minimize the need for chemical intervention.

Although some success has been achieved in developing resistant varieties, these are mainly restricted to dormant cultivars that are not well adapted to California's Mediterranean climate. Sources of resistance in nondormant cultivars have been identified but have not yet been incorporated into commercial varieties.

Grazing sheep in January and February in the Low Desert consume weevil eggs and larvae. Lambs cropping the forage down to ground level improve hay yields and quality at the first harvest. Care should be taken to ensure that sheep do not graze fields that are waterlogged from winter rains. See Chapter 17 on "Alfalfa Utilization by Livestock" for more information.

## Important Insect Pests—Aphids

Pea aphid (*Acyrthosiphon pisum* [Harris]), blue alfalfa aphid (*Acyrthosiphon kondoi* Shinji), spotted alfalfa aphid (*Therioaphis maculate* Buckton), and cowpea aphid (*Aphis craccivora* Koch) are the principal aphids associated with alfalfa (Color Plates 9.3 – 9.7). They suck large quantities of sap from the plants and inject a toxin into the plant as part of the normal feeding process. This results in stunted plants with shortened internodes and yellow, distorted, and misshapen leaves. In addition, aphids secrete large amounts of honeydew, a sugary byproduct of digestion, on which a number of sooty molds grow. These sooty molds reduce photosynthesis and render the leaves and stems unpalatable to livestock.

Aphids reproduce by giving birth to live young. These young, while still inside their mother, also have young developing within them, a phenomenon called "telescoping of generations." This is why aphid populations can build so rapidly. Under proper temperature conditions, an aphid may go from newly born to producing offspring in 5–7 days.

### Pea Aphid and Blue Alfalfa Aphid

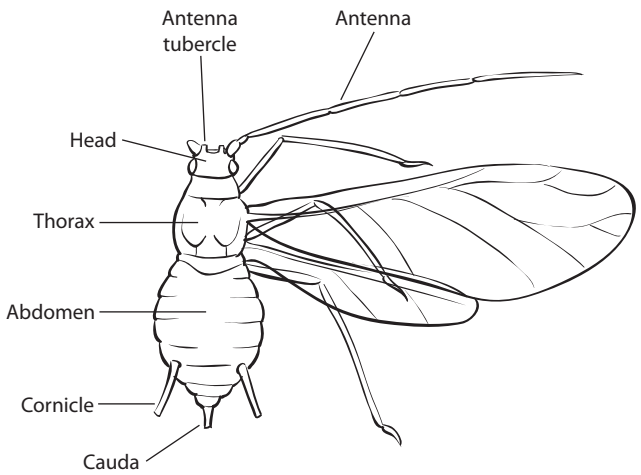
Pea aphid and blue alfalfa aphid are large, green aphids with long legs, antennae, cornicles, and cauda (Fig. 9.3). They generally occur together in alfalfa. Pea aphid (Color Plate 9.3) and blue alfalfa aphid (Color Plate 9.4) are similar in appearance but can be distinguished from each other by the antennae. The pea aphid has dark bands at the joints between the antennal segments, whereas the antennae of the blue alfalfa aphid are uniformly dark (Color Plate 9.5).

It is important to distinguish between these two aphids because the blue alfalfa aphid causes more damage than does the pea aphid; they have different economic thresholds. Recently, a pink biotype of the pea aphid has been observed in California's Central Valley. This biotype looks identical to the green pea aphid except its body is a light pink. It still retains the banding on the antennae typical of the pea aphid. It is not known if the pink biotype causes more or less damage than the green biotype, but there is some evidence that the pink biotype is less susceptible to parasites than is the green biotype. For the time being, however, they should be treated the same. Both pea aphid and blue alfalfa aphid prefer cool temperatures and commonly reach damaging levels in the spring. Pea aphid may also reappear in the fall (Fig. 9.1). Blue alfalfa aphid is



**FIGURE 9.3**

Morphological features of an aphid useful in identification.



more tolerant of cool temperatures than is pea aphid and therefore may be seen earlier in the spring.

Both species may be present in the field at the same time as the alfalfa weevil. Damage is more severe on short hay than on taller alfalfa. Both species inject a toxin into the alfalfa while feeding, but the toxin injected by the blue alfalfa aphid is more potent than that injected by the pea aphid. The blue alfalfa aphid prefers the plant terminals, whereas pea aphid is more widely distributed over the plant. Both species prefer stem tissue over leaf tissue.

### Monitoring and Management Guidelines for Pea and Blue Aphids

Stem samples are used to determine pea and blue alfalfa aphid densities. A minimum of five stems should be taken at random from each of four areas in the field, for a total of 20 stems. Care should be taken not to dislodge the aphids during removal of the stem. The stems may be shaken into a sweep net bag or beaten into a white pan or on a large sheet of white paper to dislodge the aphids for counting.

Resistant alfalfa varieties are available for the management of both pea aphid and blue alfalfa aphid and should be planted wherever these aphids are a problem. However, prolonged periods of below-normal temperatures may decrease the level of blue alfalfa aphid resistance in alfalfa, thereby resulting in injury to otherwise resistant varieties. Thus, additional sampling may be needed during such periods. New varieties with improved resistance and forage characteristics are constantly being developed. Contact your local Farm Advisor or the National Alfalfa and Forage Alliance (www.alfalfa.org), for a list of the currently recommended varieties for your area.

Pea aphid and blue alfalfa aphid are attacked by a number of predators, parasites, and diseases. The most significant predator is the ladybird beetle (Color Plate 9.21A–B), and treatment thresholds for pea aphid are based on the number of ladybird beetle adults and larvae present (Table 9.1). Other predators include green lacewing larvae (*Chrysoperla* spp.), big-eyed bugs (*Geocoris* sp.), damsel bugs (*Nabis* spp.), and syrphid fly larvae. The parasitic wasp (*Aphidius smithi* Sharama and Subba Rao), attacks pea aphid, and *A. ervi* Haliday attacks both species. The wasp lays an egg inside the aphid and, after hatching, the parasite larva kills the aphid by consuming its internal organs. Parasitized aphids, called mummies, are light tan and appear bloated. A circular hole cut into the back of the aphid indicates that the adult parasite has emerged (Color Plate 9.24).

Both aphid species are also attacked by a fungal disease (*Erynia neoaphidis* Remaudière and Hennebert). This fungus is particularly effective during periods of warm, wet weather in the spring. Aphids killed by the fungus are pink to tan and appear to be flattened against the leaf. Close inspection often reveals the presence of fungal mycelia growing on the aphid body. The parasites and fungal disease can quickly reduce the aphid population, sometimes in a matter of a few days. Growers and Pest Control Advisors (PCAs) should look for signs of parasites or disease when checking fields, and, if present, continue to check the field every 2 to 3 days to see if the aphid population declines. If it does, insecticides may not be necessary. If natural enemies fail to keep the aphid populations in check, an insecticide treatment may be needed. Economic thresholds for both pea aphid and blue alfalfa aphid are shown in Table 9.1. If both aphids are present, use blue alfalfa aphid treatment thresholds.



**TABLE 9.1**

Treatment thresholds for pea aphid and blue alfalfa aphid in the Central and Imperial Valleys of California

| Plant Height | Pea Aphid | Blue Alfalfa Aphid |
|---|---|---|
| Under 10 inches (25 cm) | 40–50 per stem* | 10–12 per stem |
| Over 10 inches (25 cm) | 70–80 per stem* | 40–50 per stem |
| Over 20 inches (50 cm) | 100 + per stem* | 40–50 per stem |

*Do not treat if the ratio of ladybird beetles to pea aphids is equal to or exceeds the following: On standing alfalfa, one or more adults to 5–10 aphids per stem or three or more larvae to 40 aphids per stem. On stubble, one or more larvae to 50 aphids per stem.

## Spotted Alfalfa Aphid

The spotted alfalfa aphid is pale yellow and has five or six rows of dark spots running lengthwise down the back of the abdomen (Color Plate 9.6). Spotted alfalfa aphids prefer warm weather and are generally found during the summer months (Fig 9.1). In the Imperial Valley, high populations may continue into the fall and winter (Fig. 9.1). The toxin injected by the spotted alfalfa aphid is extremely potent, and if large populations are present, they may kill the plant. Spotted alfalfa aphid secretes large quantities of honeydew, and plants become very sticky and covered with sooty molds at relatively low aphid densities.

### Monitoring and Management Guidelines for Spotted Alfalfa Aphid

As with pea aphid and blue alfalfa aphid, it is important to sample frequently during periods of maximum aphid activity (Fig. 9.1). Follow the guidelines listed above for sampling pea and blue alfalfa aphids to determine levels of spotted alfalfa aphid infestations. Unlike pea and blue alfalfa aphids, spotted alfalfa aphids frequently colonize the leaves, so also count aphids that may remain on the leaves. In addition, take several sweep samples in at least four areas of the field to determine the population density of ladybird beetles.

Most alfalfa varieties grown in California are resistant to spotted alfalfa aphid. These resistant varieties constitute the most important control strategy for spotted alfalfa aphid. However, biotypes of spotted alfalfa aphid capable of infesting previously resistant varieties are constantly evolving. Fields, even those planted to resistant varieties, should be checked periodically. When selecting a variety, make sure that you have the most recent information available on variety resistance (www.alfalfa.org).

Spotted alfalfa aphid is preyed on by the same predator complex that attacks pea aphid and blue alfalfa aphid. Additionally, two parasitic wasps, *Trioxys* sp. and *Praon* sp., help to keep spotted alfalfa aphid populations under control. Parasitized aphids are similar in appearance to those previously described for pea and blue alfalfa aphids. Spotted alfalfa aphids are also attacked by a fungal disease, and appear similar to diseased pea and blue alfalfa aphids, as described above.

In the event that host plant resistance fails and natural enemies do not maintain spotted alfalfa aphid numbers below economic threshold levels, insecticide intervention may become necessary. Action thresholds for spotted alfalfa aphid are shown in Table 9.2. Note that these threshold values are adjusted for the presence of ladybird beetles in the field, so ladybird beetle numbers should be determined by taking sweep net samples.

## Cowpea Aphid

Cowpea aphid is the newest aphid pest of alfalfa in California but is common in other alfalfa growing regions, especially Argentina, China, and the Middle East. It is easily distinguished from other alfalfa aphids since it is the only black aphid found in alfalfa (Color Plate 9.7). Individuals may be shiny black or a dull slate-black. They have white legs with dark bands at the joints. Although cowpea aphid has historically been present in alfalfa in very low numbers, it rarely, if ever, reached population levels that caused damage or yield loss. However, during the winter and spring of 1998, elevated populations of cowpea aphid were common in alfalfa in the Low Desert and were also found in higher that normal numbers in the High Desert. During the following two



**TABLE 9.2**

Treatment thresholds for spotted alfalfa aphid in the Central and Imperial Valleys

| Time of Occurrence | No. of Aphids per Stem |
|---|---|
| Spring months | 40 aphids per stem* |
| Summer months | 20 aphids per stem* |
| After last cutting in the fall | 50–70 aphids per stem |
| Newly seeded alfalfa in lower desert | 20 aphids per stem |

*Do not treat if the ratio of ladybird beetles to aphids is equal to or exceeds the following: On standing alfalfa, one or more adults to 5–10 aphids, three or more larvae to 40 aphids. On stubble, one or more larvae to 50 aphids.

years, it spread throughout the Central Valley from Kern to Glenn Counties and into the Intermountain counties. Historically, cowpea aphid appears during the hot summer months, then disappears as temperatures cool in the fall. However, the cowpea aphid currently infesting alfalfa appears to thrive in cool as well as hot temperatures. In the Central Valley, populations generally reach highest numbers from February through April, and in the desert, numbers peak from October through January. In the San Joaquin Valley, populations have also reached treatable levels in August and September (Fig. 9.1). Like the spotted alfalfa aphid, cowpea aphid injects a powerful toxin into the plant during feeding, and under severe aphid pressure, cowpea aphids can kill alfalfa plants. Cowpea aphid is a prolific honeydew producer, and the alfalfa becomes sticky and covered with sooty molds at relatively low aphid densities.

### Monitoring and Management Guidelines for Cowpea Aphid

Cowpea aphid is attacked by two common aphid parasites, *Lysiphlebus* sp. and *Diaeretiella* sp. These parasitic wasps have been collected throughout the state wherever cowpea aphid occurs. Parasitized aphids appear bloated, as described for pea aphid and blue alfalfa aphid. In the Low Desert, the seven-spotted ladybird beetle (*Coccinella septempunctata* L.) is an important predator of cowpea aphid. There are currently no commercially available alfalfa varieties resistant to cowpea aphid. Sample for cowpea aphid as described in monitoring and management guidelines for pea aphid and blue alfalfa aphid. Currently, no economic thresholds have been developed for cowpea aphids, and we recommend that the economic threshold values developed for blue alfalfa aphid be used until specific threshold values for cowpea aphid have been established.

## Important Insect Pests—Caterpillars

The larval forms (caterpillars) of several species of Lepidoptera (butterflies, moths, and skippers) are important pests of alfalfa. The larvae feed on foliage, and often several species may be present at one time. Damage generally occurs during the summer months (Fig. 9.1).

### Armyworms

Beet armyworm (*Spodoptera exigua* [Hübner]) and western yellowstriped armyworm (*S. praefica* [Grote]) are common pests in the Central Valley and desert valleys from June through September (Fig. 9.1). They may occasionally damage alfalfa as early as April or May in the Low Desert valleys of Southern California (Fig. 9.1). Egg masses of both species are deposited on the upper side of leaves. White cottony scales cover beet armyworm egg masses (Color Plate 9.8), and western yellowstriped armyworm egg masses are covered with gray cottony scales (Color Plate 9.11). These help protect the eggs from predators and parasites. Eggs hatch in a few days, and larvae reach full size in 2–3 weeks. The larvae pupate on or just under the soil surface.

Adults of both species are brown, nocturnal moths with a 1.25-inch (3-cm) wingspan. Because they are nocturnal, the adults are seldom seen, but they may fly up as you walk through the field, landing again a short distance away. There are four to five generations of beet armyworm and western yellowstriped armyworm per year in the Low Desert and four generations in the Central Valley. The final generations of each species overwinter as pupae in the soil.

Beet armyworm larvae are smooth skinned and are usually olive green (Color Plate 9.9), but the color varies from bright green to purplish green. They have very fine dark stripes on their backs and pale yellow stripes on each side. Western yellowstriped armyworm larvae appear smooth, are usually black, and two prominent orange-yellow stripes and many narrow stripes line each side of the body (Color Plate 9.12). The beet armyworm

possesses a dark spot on the lateral surface of the second thoracic segment (second segment with legs), whereas the western yellowstriped armyworm has a spot on the lateral surface of the first abdominal segment (first segment behind the thorax and lacking legs). First instar larvae of both species are gregarious, remaining together near where the egg mass was deposited. They web the alfalfa terminal leaves together and skeletonize the leaves by consuming the interveinal tissue but leave the leaf veins intact (Color Plate 9.10). As they skeletonize the leaves around where they hatched, the terminals turn whitish and are referred to as "whitecaps." The larvae later disperse throughout the surrounding alfalfa where they continue to consume leaf tissue.

### Monitoring and Management Guidelines for Armyworms

Monitor fields weekly by making a minimum of five 180° sweeps at each of four locations per field using a standard sweep net. Check fields weekly, then two to three times per week if populations approach the economic threshold. If the alfalfa is only a few days away from cutting, early harvest will minimize armyworm damage. The worms begin to leave the field almost immediately after cutting. If susceptible crops, such as cotton or sugar beets, are planted adjacent to the alfalfa, it may be necessary to protect them from armyworm invasion by leaving a strip of uncut alfalfa adjacent to the crop, or treating the first few rows of the adjoining crop.

*Spiders and various species of predacious bugs prey on the larvae of both armyworm species and help to maintain populations at an acceptable level.*

Spiders and various species of predacious bugs (see Table 9.3, p. 148) prey on the larvae of both armyworm species and help to maintain populations at an acceptable level. A wasp, *Hyposoter exiguae* (Viereck), preys on both armyworm species by depositing an egg inside the larva. The developing parasite larva consumes the internal organs of the armyworm, which results in its death. Parasitism can be observed by pulling the heads from 0.5 inch (1.3 cm) or longer armyworms and squeezing the body contents out toward the head end. The *Hyposoter* larva, which is a light translucent green, will be pushed out of the parasitized armyworm (Color Plate 9.23). Checking for parasitism is important because the economic threshold levels are designed to take parasite activity into account. Armyworm larvae are also attacked by a nuclear polyhedrosis virus. This virus kills the larvae within a few days. Diseased caterpillars first appear yellowish and limp and after death hang from the plants as shapeless, dark tubes oozing the disintegrated body contents. The virus may completely control an armyworm infestation within a few days. If chemical controls are required, treat with an insecticide when there are 15 or more nonparasitized 0.5-inch- (1.3-cm-) long armyworms of either species per sweep. Select a chemical such as *Bacillus thuringiensis* Berliner that is harmless to the armyworm's natural enemies.



## Alfalfa Caterpillar

The alfalfa caterpillar (*Colias eurytheme* Boisduval) is the larval form of one of the most noticeable pests of alfalfa; the bright yellow butterflies are commonly seen in the vicinity of alfalfa fields throughout the summer (Color Plate 9.13). Adults migrating between fields may be so numerous that they cause a potential driving hazard by covering the windshields of vehicles. They are common in the Central Valley from June through September and from May through October in the Imperial Valley (Fig. 9.1).

The adult female deposits single, yellow, football-shaped eggs on the upper surface of alfalfa leaves (Color Plate 9.14). Oviposition takes place on new growth alfalfa (<6 inches [15.2 cm] tall). These eggs hatch in 3–7 days, and the larvae consume the alfalfa leaves. The velvety green larvae have a white stripe along each side of the body and develop into 1.5-inch- (3.8-cm-) long individuals in 14–17 days (Color Plate 9.15). When mature, the larvae pupate, forming a yellowish chrysalis that is attached to an alfalfa stem. They produce four

to five generations per year, and each generation is closely synchronized with the hay cutting cycle; thus they pupate before the hay is cut.

Alfalfa caterpillar larvae consume the entire leaf, including the veins, as opposed to armyworm larvae that consume the interveinal tissue but leave the veins intact. The alfalfa caterpillar is parasitized by a wasp, *Cotesia medicaginis* (Cresson). Parasitized larvae are easily distinguished by pulling the head of a caterpillar larva off and gently "rolling" the white, translucent parasite larva out (Color Plate 9.22). It is important to determine the amount of parasitism because the economic threshold levels take the amount of parasitism into account. These parasitized alfalfa caterpillar larvae perish in about 5 days, although they stop feeding soon after parasitism begins. The parasite larva spins a fuzzy, yellowish cocoon that is attached to the upper surface of the leaflet. Alfalfa caterpillars may also be attacked by naturally occurring *B. thuringiensis*. When infected, the larvae turn brown and appear to disintegrate.

### Monitoring and Management Guidelines for Alfalfa Caterpillar

Monitor alfalfa caterpillar populations by taking a minimum of five 180° sweeps in four locations throughout the field. If cutting is only a few days away, the alfalfa caterpillar can be controlled by harvesting. Border-strip cutting can also be used to manage alfalfa caterpillar populations. This technique serves to retain parasite larvae in the alfalfa fields, thus resulting in improved biological control. Microbial insecticides, such as *B. thuringiensis,* can be applied in worst-case situations. *Bacillus thuringiensis* protects the parasites that will aid in controlling future generations. An average of 10 nonparasitized larvae per sweep indicates that an insecticide treatment is needed.

## Leafhoppers

Leafhoppers are very important pests in Midwestern alfalfa production systems, but less important in the Mediterranean and desert zones of California. Of the several species of leafhoppers that inhabit alfalfa stands in California, three are important pests: potato leafhopper (*Empoasca fabae* [Harris]), garden leafhopper (*E. solana* DeLong) and Mexican leafhopper (*E. mexara* Ross and Moore). They are collectively known as "*Empoasca* leafhoppers." They all have the same general overall appearance and can only be distinguished from each other by examining the genitalia. They all cause identical damage. Adults are small (0.125-inch- [0.3-cm-] long), bright green, wedge-shaped insects (Color Plate 9.16). Nymphs (immatures) also have green, wedge-shaped bodies and run rapidly when disturbed. They may run forward, backward, or from side to side. Their curious movement, plus their shape, serves to distinguish them from lygus bug nymphs and slower-moving aphids. Other green leafhoppers (sharpshooters) may occasionally be present in alfalfa, but they are much larger and prefer to feed on grassy weeds, particularly bermudagrass, rather than alfalfa. Other small leafhoppers found in alfalfa are brown or gray and do no apparent damage.

The most common damage symptom caused by *Empoasca* leafhoppers is a yellow, wedged-shaped discoloration at the tip of each leaflet (Color Plate 9.17). Frequently, the leaf margin and tissue surrounding this area turns red. This symptom may occasionally be confused with boron deficiency but can easily be distinguished from the latter by the presence of the insect. Plants may become stunted and have very short internodes. Although *Empoasca* leafhoppers may be found throughout the year, damage in the Central Valley generally occurs during July, August, and occasionally into September. In the Imperial Valley, damage may begin as early as June and continue through September (Fig. 9.1).

### Monitoring and Management Guidelines for Leafhoppers

At the first sign of injury, sample the field with a standard sweep net. Although we recommend that field margins be excluded when sampling for most insects, leafhopper sampling is the exception because infestations frequently begin on the field margin. Be sure to include field edges in your samples, and keep the results separate from the rest of the field. Often, leafhopper infestations are confined to the first 50–100 feet (15-30 m) of the field margin. If this is the case, treat only the field edges if leafhopper counts exceed the economic threshold but are not found farther into the field.

A minimum of four areas over the entire field should be sampled by taking 10 sweeps in each area and counting the number of adults and nymphs. If economic thresholds are reached (see below) and alfalfa is within a few days of harvest, cutting will control *Empoasca* leafhoppers. If alfalfa is 2 or more weeks away from harvest, treatments should be applied if counts reach five leafhoppers (adults and nymphs combined) per sweep. Alfalfa scheduled for harvesting in 10 days to 2 weeks should be treated if counts reach 10 individuals per sweep.

Although some alfalfa varieties with resistance to potato leafhopper have been developed, there are none available that are adapted to the arid West. Resistant varieties are available for areas of the Midwest and Northeast. These are generally dormant varieties that are not grown in our area.

## Occasional Alfalfa Pests

### Cutworms

Granulate cutworm (*Agrotis subterranea* [F.]) and variegated cutworm (*Peridroma sausia* Hübner) are occasional pests of High Desert and Central Valley alfalfa, but are frequent pests in the Low Desert when alfalfa is planted on beds. The white or greenish eggs are laid in irregular masses on alfalfa leaves or stems, often near the base of the plant. Larvae can grow to 2 inches (5 cm) in length. The heavy-bodied larvae appear as smooth-skinned caterpillars of various colors and patterns. Larvae roll into a "C" shape when disturbed (Color Plate 9.18). Cutworm larvae hide under loose soil, in soil cracks, or under duff during the day and move to the plants at night to feed.

In the Central Valley, variegated cutworm populations may develop in weedy areas and migrate into seedling stands or occasionally to mature stands. Seedling alfalfa stands can be severely damaged by cutworms, which cut the seedlings off at or just below the soil surface. Established fields are damaged when cutworms cut off new growth or feed on alfalfa foliage.

*Granulate and variegated cutworms are occasional pests of the High Desert, but are frequent pests in the Low Desert when alfalfa is planted on beds.*

Granulate cutworm is a devastating pest in bed-planted alfalfa but can also be a pest of alfalfa planted on flat ground. Low Desert alfalfa fields are attacked by granulate cutworm from May through October, but the pest is resident in fields throughout the year. Established alfalfa fields can be severely injured when cutworms cut off new shoots at or below ground level following harvest. The pest often goes undetected after cutting and hay removal. The problem becomes apparent when the field is watered and there is little or no regrowth as a result of cutworms feeding.

### Monitoring and Management Guidelines for Cutworms

Cultural practices can help with management of cutworms. Cutworms are most injurious in fields with high plant residue. Preplant tillage and abatement of weedy refuge areas around fields help prevent cutworm infestations. Flood irrigation will drown many cutworm larvae. Flood irrigation during daylight hours will attract egrets, ibises, gulls, and other birds that prey on the cutworm as the advancing water forces the larvae from hiding. Monitoring and treatment guidelines have not been established for cutworms. Cutworms can be detected by looking under duff and carefully digging to

a depth of 1 inch (2.5 cm) in loose soil near alfalfa crowns. When cutworm numbers exceed one or two per foot of row, or if severe damage is apparent, treatment is usually warranted. If chemical controls become necessary, it is recommended that fields be sprayed near sundown when cutworms are becoming active.

## Alfalfa Webworm

Several species of webworms may occasionally damage alfalfa, but the alfalfa webworm (*Loxostege cereralis* [Zeller]) is the most common. Webworms are caterpillars that feed primarily on leaves in areas protected by webs. Larvae are green to yellow with a broad light-colored stripe down the middle of the back, and they vary from 0.5 to 1.5 inches (1.2 to 3.8 cm) in length. Webworms overwinter as larvae in the soil. Females lay eggs when the adults emerge in early spring. Larvae feed for 3 to 5 weeks. Early feeding takes place beneath webbing on the undersides of the leaves. If numbers are high, this webbing will be clearly visible and will cover extensive areas of foliage. As the webworms grow larger, they venture out from the webbing but will rapidly retreat into it when disturbed. Management actions are seldom warranted and no treatment thresholds exist.

**FIGURE 9.4**

Clover root curculio larvae can be distinguished from ground mealy bug by its brown head capsule and lack of waxy filaments.

## Alfalfa Looper

Alfalfa looper (*Autographa californica* [Speyer]) larvae are about 0.75 inch (1.9 cm) long. This greenish caterpillar tapers from back to front and has a single white stripe on either side of the abdomen. It walks with a characteristic looping motion. Larvae feed on leaves, causing ragged-edged holes in the leaf and on the leaf margins. Damage is most evident in spring. Control of alfalfa loopers is seldom needed.

## Clover Root Curculio

The clover root curculio (*Sitona hispidulus* F.), is a recognized alfalfa pest in the eastern half of the United States but is generally not a problem in California. Clover root curculio is more common in the sandy soils of the San Joaquin Valley than in the heavier soils of the Sacramento Valley. The adults are slightly smaller than alfalfa weevil adults and are a mottled gray-brown. The damage is done by the legless, white grub-like larvae (Fig. 9.4) that feed on alfalfa roots, leaving gouges in the taproot. This damage has been detrimental to alfalfa yield and stand longevity in the eastern United States and also facilitates root rot diseases by providing entry points for fungi. In California, damage is usually limited, and there are no thresholds or control measures available.

## Ground Mealybug

Most mealybugs are foliage feeders, but there is a group of mealybugs that feed exclusively on roots. The ground mealybug, *Rhizoecus kondonis* Kuwana, feeds on alfalfa roots and can cause severe damage to alfalfa. Ground mealybug is restricted to the heavier soils of the Sacramento Valley and is not found in the San Joaquin or Imperial Valleys. Feeding interacts with stressful environmental conditions, resulting in greatly reduced plant growth that is particularly evident during the summer. There are three ground mealybug generations per year; populations peak in early winter, spring, and midsummer. All life stages live in the soil. Ground mealybug is a small, (1-2 mm)

whitish insect. The ground mealybug has slender, waxy filaments that form a sort of netting over some individuals (Fig. 9.5). The ground mealybug also secretes a small amount of wax, which can give the soil a somewhat bluish appearance when the mealybugs are abundant.

Infestations in alfalfa fields generally occur in circular patches and spread slowly. There are no thresholds or control measures for this pest. Crop rotation may help, but this pest appears to survive on several crop plant and weed species. There is differential survival across host species, so rotation to a less-preferred host may aid in management. In a greenhouse study, greatest survival was on potato, tomato, safflower, and alfalfa, followed by cotton, cantaloupe, dry land rice, sugar beets, and wheat. There was only slight survival on field corn and kidney beans. However, there were no plant species without some level of survival.

## Spider Mites

Spider mites (*Tetranychus* spp.) are pests in alfalfa grown for seed, and only infrequently inhabit alfalfa grown for hay. Serious damage in hay fields is generally associated with water stress. Spider mite infestations are usually confined to the lower leaves, but in severe infestations, the terminals may be webbed together. Infested leaves are covered with webbing and turn yellow. Spider mites are small pests, with adults about the size of a small pinhead, variable in color (green or yellow) with dark pigmented spots. Adult spider mites have eight legs and are oblong to spherical in shape. The damaged leaves may become desiccated and fall from the plants. Spider mites have become more common in alfalfa grown for hay in the Low Desert in recent years. Definitive monitoring and treatment guidelines have not been developed because spider mites are a sporadic problem in alfalfa grown for hay. A timely irrigation usually reduces the impact of spider mites within a few days.

**FIGURE 9.5**

The ground mealybug has slender, waxy filaments that form a sort of netting over some individuals.



## Silverleaf Whitefly

Silverleaf whitefly (*Bemisia argentifolii* Bellows and Perring), causes serious damage to over 200 crops including alfalfa. Alfalfa has been subject to significant yield and quality loss in the Imperial Valley in some years. Although this pest can also be found in the southern San Joaquin Valley (south of Merced County) during late summer, it has never reached levels capable of causing serious injury to alfalfa. Silverleaf whitefly adults are tiny (0.06 inch [0.15 cm] long), yellowish insects with white wings. Their wings are held roof-like over the body and generally do not meet over the back but have a small space separating them. Eggs are tiny, cigar-shaped, and creamy-white and are laid randomly on the undersides of leaves. Nymphs are found on the underside of the leaves, appear scale-like, and are clear to translucent yellow. Dense populations of silverleaf whitefly reduce hay quality by contaminating alfalfa with honeydew and sooty molds that grow on the honeydew. As noted in the discussion of

*Silverleaf whitefly has caused significant yield and quality loss to alfalfa in the Imperial Valley.*

aphids, sooty molds may reduce photosynthesis and the palatability of alfalfa to livestock.

Definitive monitoring and treatment guidelines have not been developed for whitefly control in alfalfa. Whitefly-resistant cultivars are available and should be planted in areas with a history of silverleaf whitefly damage to alfalfa.

## Grasshoppers and Mormon Crickets

Grasshoppers (*Melanoplus* spp., *Trimerotropis* spp.) are normally of little concern in desert alfalfa. However, populations may build up in the foothills around the Central Valley after a wet spring, and later migrate to nearby alfalfa fields. Damage is usually limited to a few weeks after weeds dry up in the foothills. Grasshoppers may complete one to three generations per year, depending on the species and geographic location.

Control can sometimes be achieved by spraying an insecticide around field margins adjacent to the source of migration or by broadcasting insecticide bait over a vegetation-free buffer strip in advance of the migrating grasshoppers.

Mormon crickets (*Anabrus simplex* Haldeman) are not true crickets but are more closely related to katydids. The heavy-bodied, tan adults are about 1–2 inches (2.5–5 cm) long. The wings are small and useless; these insects do not fly. The antennae are as long as the body, and the female has a sword-shaped ovipositor as long as the body. When they are half grown, they begin migrating from their rangeland breeding grounds. The migrations occur at air temperatures of 65°–95°F (18–35°C).

Mormon crickets become pests only once or twice in a decade. Management centers on preventing invasions of fields with barriers or insecticide baits. Because these insects cannot fly, linear barriers of 10-inch (25 cm) strips of 28- to 30-gauge galvanized iron, held on edge with stakes, may stop swarms. Soil pits or water traps may be made at intervals to catch crickets halted by the barrier. Bait treatments on the border of the field may be effective at limiting an invasion.

## Threecornered Alfalfa Hopper

The threecornered alfalfa hopper (*Spissistilus festinus* [Say]) is commonly found in desert alfalfa but is not a problem in the Central Valley, although numbers in the San Joaquin Valley have increased substantially in recent years. Adults are light green, thick-bodied, triangular insects about 0.25 inch (0.6 cm) long and readily fly when disturbed (Color Plate 9.19). Nymphs are grayish-white, soft bodied, and have saw-toothed spines on their backs. Nymphs are confined to the lower portions of the plant and may not be picked up in a sweep net. Populations build up in spring and persist into fall. They feed by sucking juices from the plant. Adult female treehoppers girdle stems by depositing eggs, causing the stem and leaves to turn red, purple, or yellow above the girdle. Definitive monitoring and treatment guidelines have not been developed.

## Blister Beetles

Blister beetles (*Epicauta* spp., *Lytta* spp., *Tegrodera* spp.) are narrow and elongate, and the covering over the wings is soft and flexible. They may be solid colored (black or gray) or striped (usually orange, or yellow and black) and are among the largest beetles likely to be swept from alfalfa (Color Plate 9.20). Blister beetles contain a chemical, cantharidin, which is toxic to livestock. A few ingested insects are enough to kill a horse. Cantharidin is contained in the hemolymph (blood) of the beetles and may contaminate forage directly by beetles killed during harvest and incorporated into baled hay or indirectly by transfer of the hemolymph from crushed beetles onto forage. As the name implies, handling these insects may result in blisters, similar to burns, on the hands or fingers. Blister beetles have been a serious problem in alfalfa in the northern, midwestern, and southern United States for many years but, until recently, have not

been a problem in California. In recent years, alfalfa contaminated with blister beetles in the southern Owens Valley has been linked to the death of several dairy cows. It is not known if blister beetles may become more widespread in California. Growers and PCAs are advised to be on the lookout for blister beetles and to contact their Farm Advisor if these insects are found. Although most likely encountered in spring, they may be found any time during the growing season. To reduce the incidence of blister beetles in alfalfa, hay should be cut before bloom. If beetles are found, remove the conditioner wheels from the swather to prevent crushing the beetles. Also, these beetles congregate on field edges or in groups within the field. Such areas should be skipped when cutting or the bales picked up separately and isolated from bales picked up from the rest of the field.

## Thrips

Thrips are minute, slender-bodied insects usually possessing two pairs of long, narrow wings, the margins of which are fringed with long hairs. Thrips are commonly found in alfalfa throughout the year. Western flower thrips (*Frankliniella* spp.) are distributed statewide. They feed mainly on pollen but will also feed on leaves by rasping the leaf surface. Under unusually high population levels, they may cause leaf crinkling, puckering, and distortion. This is often interpreted as economic injury. There is no evidence, however, that western flower thrips are causing economic damage, despite the leaf distortion. Insecticide control is not recommended because the damage done to natural enemy populations typically greatly outweighs any benefits derived from controlling the thrips.

*There is no evidence that western flower thrips are causing economic damage, despite the leaf distortion they cause.*

One thrips species, *Caliothrips phaseoli* (Hood), is emerging as a possible pest, particularly in the Imperial Valley. This thrips is similar to the bean thrips (*C. fasciatus* [Pergande]), but can cause damage to seedling alfalfa. During fall 2001 and all of 2002, *C. phaseoli* caused stand loss in Imperial Valley seedling alfalfa fields. These thrips cause leaf spotting and leaf drop in established alfalfa stands. Monitoring and treatment guidelines have not been developed. However, insecticide applications may be required if seedlings are being killed by this pest.

## Beneficial Insects—Natural Enemies of Pests

Alfalfa is an important reservoir for natural enemies of insect pests (Table 9.3). It is important for growers to identify these insects (Color Plates 9.21–9.24) and to monitor their populations. These natural enemies have been discussed together with the individual pest species. Do not treat alfalfa with insecticides until the economic treatment level for a specific pest has been reached and the predator and parasite populations have been assessed for their potential roll in controlling the pest. Insecticides often destroy beneficial insects, leading to severe secondary pest outbreaks. Alfalfa produces many beneficial insects that move into other cropping systems and provide biological control of pests there.

Birds are important predators of insect pests in desert alfalfa. Egrets, ibis and gulls feed on crickets, cutworms, and other insects forced to move at the leading edge of flood irrigation water. Blackbirds in the Imperial and Central Valleys eat alfalfa weevil larvae, aphids on alfalfa stems, cutworms, and other insect pests.

**TABLE 9.3**

Natural enemy species and the species they prey on that are commonly found in alfalfa

| Common name | Scientific name | Predator | Parasite | Prey |
|---|---|---|---|---|
| | *Bathyplectes curculionis*<br>*B. anurus* | | ■<br>■ | Alfalfa weevil<br>Egyptian alfalfa weevil |
| | *Aphidius* spp. | | ■ | Aphids |
| | *Lysiphlebus* spp. | | ■ | Aphids |
| | *Diaeretiella* spp. | | ■ | Aphids |
| | *Cotesia (Apenteles) medicaginis* | | ■ | Alfalfa caterpillar |
| | *Hyposoter exiguae* | | ■ | *Spodoptera* spp. caterpillars |
| | *Anaphes* sp. | | ■ | Lygus egg |
| | *Trichogramma* spp. | | ■ | Caterpillar eggs |
| Collops beetles | *Collops* spp. | ■ | | Various small insects |
| Convergent ladybird beetle | *Hippodamia convergens* | ■ | | Aphids and whiteflies |
| Seven-spotted ladybird beetle | *Coccinella septempunctata*<br>*Coccinella* spp. | ■ | | Aphids and whiteflies |
| Bigeyed bugs | *Geocoris* spp. | ■ | | Aphids and small caterpillars |
| Minute pirate bugs | *Orius* spp. | ■ | | Aphids and small caterpillars |
| Damsel bugs | *Nabis* spp. | ■ | | Caterpillars and other insects |
| Assassin bugs | *Zelus* spp.<br>*Sinea* spp. | ■ | | Caterpillars and other insects |
| Lacewings | *Chrysoperla* sp.<br>*Chrysopa* sp. and others | ■ | | Aphids and small caterpillars |
| Spiders | Various species | ■ | | Caterpillars and other insects |
| Six-spotted thrips | *Scolothrips sexmaculatus* | ■ | | Various small insects, eggs, and mites |



## Additional Reading

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Summers, C.G., and L.D. Godfrey. 2001. Insects and mites in: UC IPM Pest Management Guidelines for Alfalfa Hay. http://www.ipm.ucdavis.edu/PMG/selectnewpest.alfalfahay.html.

Summers, C.G., D.G. Gilchrist, and R.F. Norris, eds. 1981. Integrated pest management for alfalfa hay. University of California Division of Agriculture and Natural Resources, Oakland. Publication 4104.

University Of California Integrated Pest Management Guidelines. http://www.ipm.ucdavis.edu/pmg/selectnewpest.alfalfa-hay.html

# Color Plates

## Important Insect Pests

### PLATE 9.1

Adult alfalfa weevils are gray-brown beetles with a pronounced snout.

### PLATE 9.2

Alfalfa weevil larvae are bright green in color with a black head and a prominent white stripe down the back.

### PLATE 9.3

Pea aphids are large aphids with long legs, antennae, and cornicles. They are bright green in color and both winged and wingless forms may be found feeding on the stems.

### PLATE 9.4

Blue alfalfa aphids are also large green aphids with an appearance very similar to that of the pea aphid. They tend to be a bit darker in color, hence the name "blue alfalfa aphid."

### PLATE 9.5

Pea and blue alfalfa aphids can be distinguished by examining the antennae. The antennae of the pea aphid, shown here, has a dark band at each joint while the antennae of the blue alfalfa aphid are a uniform brown color.

### PLATE 9.6

Spotted alfalfa aphids are easily distinguished by the several rows of dark spots down their backs.

### PLATE 9.7

Cowpea aphids are dull or shiny black in color with white legs. They can be found any time of the year. They are the only black aphid to be found in alfalfa.







## PLATE 9.8

Beet armyworms lay their eggs in clusters on the upper surface of the leaf. The female removes scales from her body and packs them around the egg mass as protection from predators and parasites. In the beet armyworm, the scales are white in color.

## PLATE 9.9

The beet armyworm is a large, smooth skin caterpillar. They are usually olive green in color, but may vary from bright green to almost black. They have a prominent light strip down the side.

## PLATE 9.10

Both beet armyworm and western yellow striped armyworm feed on the leaves. They consume leaf material from between the veins leaving the veins intact.

## PLATE 9.11

Western yellow striped armyworm also lays its eggs in clusters on the upper surface of the leaf. The eggs are surrounded by gray scales as protection from predators and parasites.

## PLATE 9.12

Western yellow striped armyworm larvae are smooth skin caterpillars. The are usually dark in color, but may occasionally be green. They have orange or yellow stripes down the side.

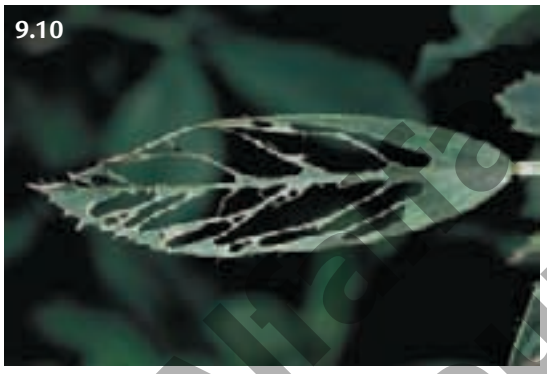
## PLATE 9.13

Alfalfa caterpillar adults are light to dark yellow in color. When huge numbers of these butterflies can be seen flying into alfalfa fields, it is a sign of an upcoming problem.

## PLATE 9.14

Alfalfa caterpillar eggs are laid singly on the upper leaf surface. They are whitish in color and resemble a football on a kicking tee.









## PLATE 9.15

Alfalfa caterpillar larvae are bright green with a white stripe along the side. The body is covered with small hairs which give the larvae a "velvety" appearance. When feeding, alfalfa caterpillar larvae consume the entire leaf.




## PLATE 9.16

*Empoasca* leafhoppers are small, wedge shaped insects that are bright green in color.

## PLATE 9.17

*Empoasca* leafhopper feeding results in reddening and yellowing of the foliage. The wedge shaped discoloration shown here is classic leafhopper damage.

## PLATE 9.18

Cutworm larvae frequently curl up into a "C" shape when disturbed.



## PLATE 9.19

The three cornered alfalfa hopper is increasing in number in both the Central Valley and the southern deserts.

## PLATE 9.20

The soldier blister beetle, also known as the iron cross blister beetle, has been found in small numbers in the High Desert of California.

## Natural Enemies of Pests

### PLATES 9.21

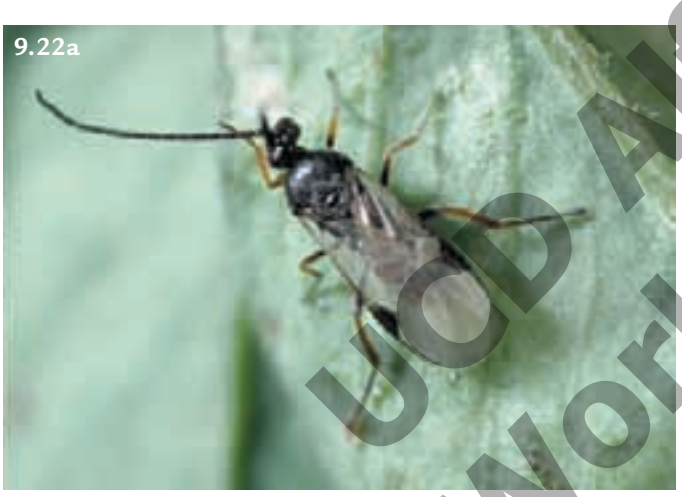
(A) Ladybug adults and (B) larvae are aphid predators and consume large numbers of these pests.

### PLATES 9.22

Alfalfa Caterpillar Parasite. (A) The alfalfa caterpillar is attacked by a parasitic wasp. (B) The parasite larva can easily be expressed from the living caterpillar to check for parasitism. (C) The "fuzzy" yellow pupa is found on the upper surface of the leaf.


9.21a


9.21b


9.22a


9.22b


9.22c

## PLATES 9.23

*Hyposoter.* (A) Armyworms are parasitized by a large wasp. (B) The parasite larva is greenish in color and can easily be expressed from the caterpillar. (C) The pupa can be found on the upper surface of the leaf and are mottled black and white.






## PLATE 9.24

Aphid Parasite. Aphids are attacked by several parasitic wasps, which develop inside of the aphid's body. The parasitized aphid appears bloated and is usually light tan in color. The round hole indicates that the parasite has emerged.

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