INSECT PEST MANAGEMENT IN THE WESTERN US: WEEVILS, APHIDS AND CATERPILLARS

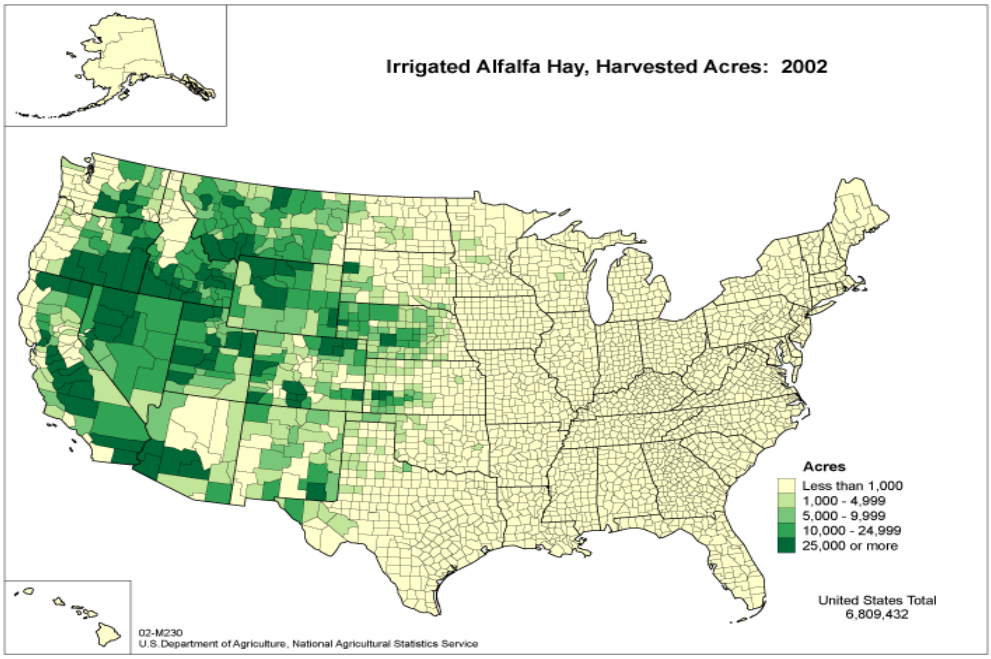
Michael D. Rethwisch[1]

ABSTRACT

Insect pest management in the western U.S. is primarily focused on alfalfa weevils, and various species of aphids and caterpillars. Good economic thresholds for alfalfa weevils do not currently exist for the entire western U.S. due to more than one strain of weevil and a number of altitudes and associated differences in alfalfa production. Aphids cause greatest yield loss when infestations begin earlier in the regrowth cycle. A number of caterpillars can cause economic loss to alfalfa grown in the western U.S.

INTRODUCTION

Welcome to the WAC. WAC means different things to different people. A number of years ago the first response for WAC would have been Women's Army Corps. Due to sports media exposure most people today would respond with "Western Athletic Association". At this conference it may mean "Western Alfalfa Conference", a reference that would also include almost all of the irrigated alfalfa hay in the United States (Figure 1). For this particular discussion WAC stands for **w**eevils, **a**phids and **c**aterpillars.



[1] Michael D. Rethwisch, Crop Production Farm Advisor, UCCE – Riverside County. 290 N. Broadway, Blythe, CA 92225-1649 Email: *mdrethwisch@ucdavis.edu*: **In**: Proceedings, 2006 Western Alfalfa & Forage Conference, Sponsored by the Cooperative Extension Services of AZ, CA, CO, ID, MT, NV, NM, OR, UT, WA, WY. Published by: UC Cooperative Extension, Agronomy Research and Extension Center, Plant Sciences Department, University of California, Davis 95616. (See http://alfalfa.ucdavis.edu for this and other alfalfa proceedings.)

WEEVILS

The alfalfa weevil is the most damaging insect of alfalfa in the United States (USDA-APHIS 1991). One-hundred years ago this was not the situation as it was difficult to find an alfalfa weevil, *Hypera postica* (Gyllenhal), in the United States, as it was first reported in the U.S. in 1904 near Salt Lake City, Utah (Titus, 1910). Since then alfalfa weevils have spread throughout the Intermountain West from this infestation. This population became known as the western strain of the alfalfa weevil in light of two other alfalfa weevil strains being introduced to the U.S. The Egyptian alfalfa weevil strain was found in 1939 at Yuma, Arizona (Wehrle, 1940), and the eastern alfalfa weevil strain in Maryland in 1952 (Poos and Bissell, 1953). The latter two strains have also spread, with alfalfa weevils now found throughout the contiguous 48 states as well as into Canada and Mexico (Hsaio 1993). In many places the strains overlap (Fig. 2), and in New Mexico all three strains are present and potentially overlap (Bundy et al., 2005).

Recent DNA work in New Mexico indicates that there may be additional strains present in the U.S. Although all alfalfa weevils collected from Valencia County in New Mexico (county immediately south of Albuquerque) sequenced using restriction patterns were positive for western strain of alfalfa weevil, 20% of these same weevils tested when using nucleotide sequencing did not match any known strain. This new strain is closest to the Asian or Xinjiang strain although there was still 23.3% differentiation (Bundy et al., 2005 and references therein). Nucleotide sequencing detected only eastern, Egyptian and western strain weevils in all other primary hay growing locations in New Mexico however (Bundy et al., 2005).

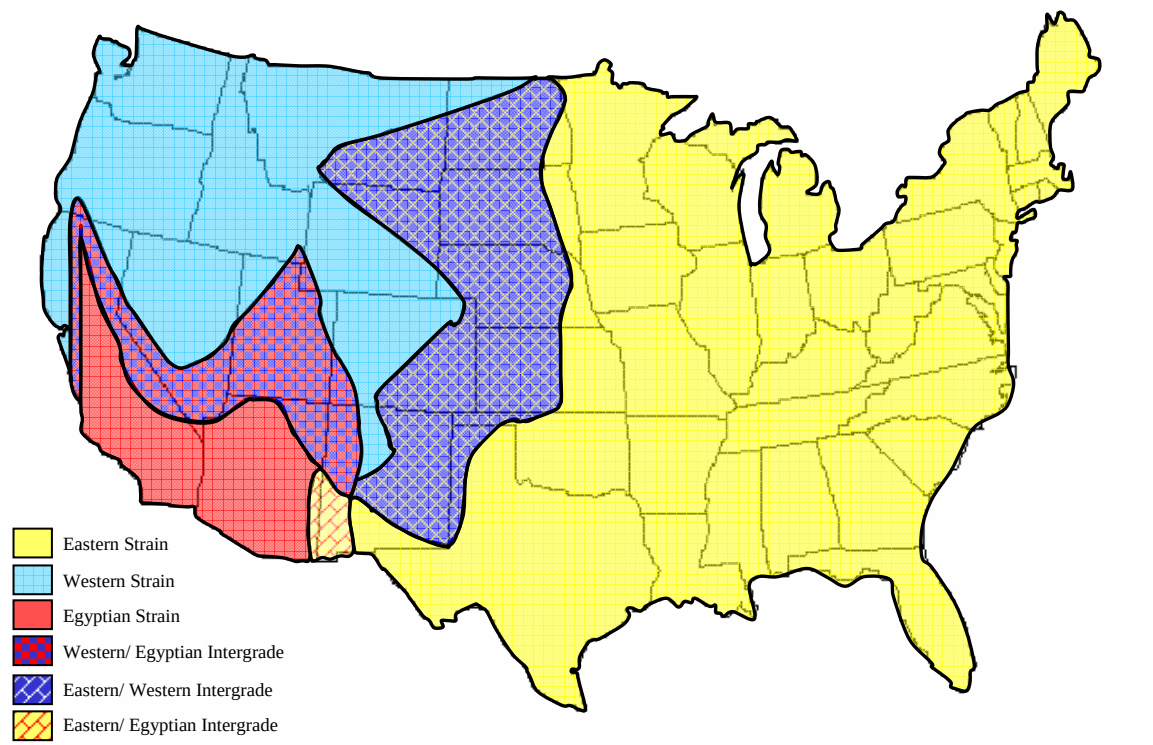


Figure 2. Geographical distribution of alfalfa weevil strains in the U.S. (C. Scott Bundy, N.M.S.U.).

Strain Differences

The three weevil strains differ somewhat in the details of their biology. Western strain alfalfa weevil larvae tend to peak 1±3 weeks after eastern strain alfalfa weevil larvae (Rethwisch and Manglitz, 1986). This same difference in larval peaks would also be expected for western strain alfalfa weevils when compared with Egyptian strain alfalfa weevils. Knowing the alfalfa weevil strain(s) present in a local area is therefore important to growers and PCAs, because genetics and other factors affect alfalfa weevil behavior and subsequent management and control due to strain differences. In the western U.S., areas with multiple strains of alfalfa weevils present (intergrades) may therefore expect multiple population peaks, due to multiple strains of alfalfa weevils as well as partial second generations of alfalfa weevils.

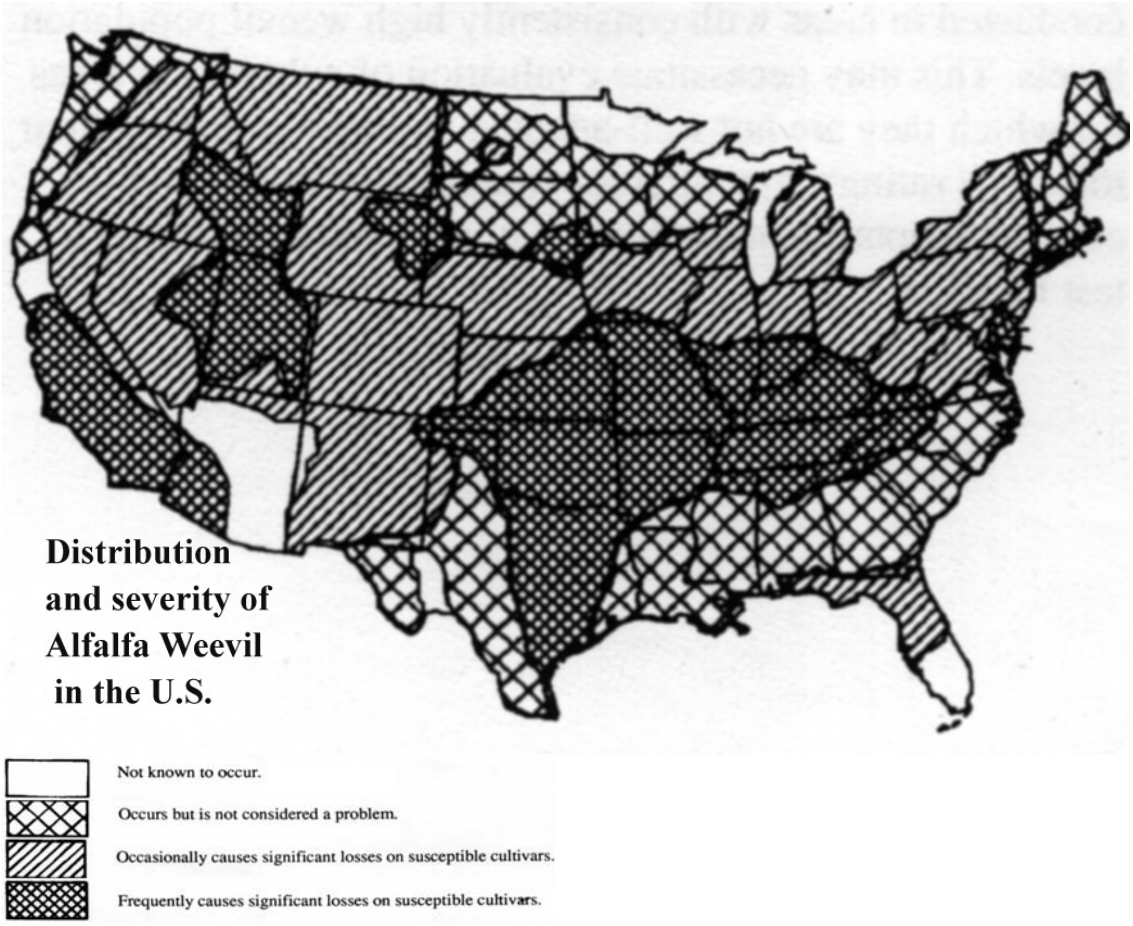


Fig. 3. U.S. distribution and severity of alfalfa weevil as of 1991. (Ratcliffe, 1991).

Thresholds for Control of Alfalfa Weevil

A number of eastern states have developed excellent treatment thresholds for alfalfa weevil. Data from Ohio indicate that feeding of one larvae per stem on 12-inch-high alfalfa will result in a loss of 0.4 tons of dry hay per acre, but one larvae per stem on 16-inch-high alfalfa will cause a loss of only 0.1 tons per acre. Thus, the yield impact of weevil feeding on alfalfa declines as alfalfa stand height increases, and decisions to treat alfalfa for weevil should be focused on an alfalfa stand when larvae can be readily found

on alfalfa that is 12 inches or less in height. Once alfalfa is 16 inches or more in height, early cutting is a preferred option for reduction of weevil impact.

The proportion of stems exhibiting tip feeding is an indicator of weevil abundance. Detection of 25% tip feeding on 6-inch alfalfa, 50% tip feeding on 9-inch alfalfa, or 75% tip feeding on 12-inch alfalfa indicates a potential problem. Since evaluation of tip feeding is rather variable among field personnel, the final decision to apply a foliar treatment should be based on an actual count of weevil larvae per stem.

Table 1. Action thresholds relevant to stand height, tip feeding, and density of larvae per stem (Ohio State University).

Stand Height Inches	Indiction of Problem % Tip Feeding	Problem Confirmation Larvae per Stem	Recommended Action
6	25	1	Recheck in 7 days
9	50	> 1	Spray
12	75	> 2	Spray or harvest
16	100	> 4	Harvest early
When harvested early due to weevil, check within one week for regrowth.			

Treatment and feeding loss thresholds for alfalfa weevils from Oklahoma State University indicate different yield losses than noted from Ohio. Yield reduction of alfalfa due to defoliation by weevil larvae is about 170 lb/acre **in the first crop** for each increase of 1 larva/stem in the population. An additional reduction of about 140 lb/acre occurs **in the second crop** due to loss of vigor in damaged alfalfa stands. With combined losses due to actual feeding damage in the first crop and residual effects later totaling more than 300 lb/acre for each increase of 1 larva/stem, it is essential that timely, effective insecticide applications be made when results of field scouting indicate that weevils are present in high numbers and **potential losses** due to feeding will exceed the cost of control (at the economic threshold). The time period when larval numbers exceed the economic threshold may vary greatly by year and location in Oklahoma, ranging from late February to mid April.

Alfalfa weevil treatment thresholds available from the University of Nebraska (Fig. 4) go a step further than the previously presented thresholds by taking into consideration the economic value of alfalfa hay. As price of alfalfa hay increases, fewer alfalfa weevil larvae per stem are necessary to reach the economic injury level to justify initiation of treatments for weevil larvae control.

In the western U.S. some thresholds for weevil control treatment decisions are available. California uses 20 larvae per sweep as their threshold without any references to plant height. Sweeping is subjective, however, as a tall person will cover a much larger area with a sweep than someone shorter due to the radius involved with the sweep area. Utah State University notes that control is warranted if (1) more than 2 larvae per stem occur

on alfalfa 10- 14" high, (2) more than 2.5 larvae per stem occur on alfalfa 15-18" high, or (3) more than 3 larvae per stem occur on alfalfa more than 18" high. At lower numbers of larvae per stem, sample again in 3-5 days if more than one larva occurs per stem. Sample again in 7 days if less than one larva occurs per stem.

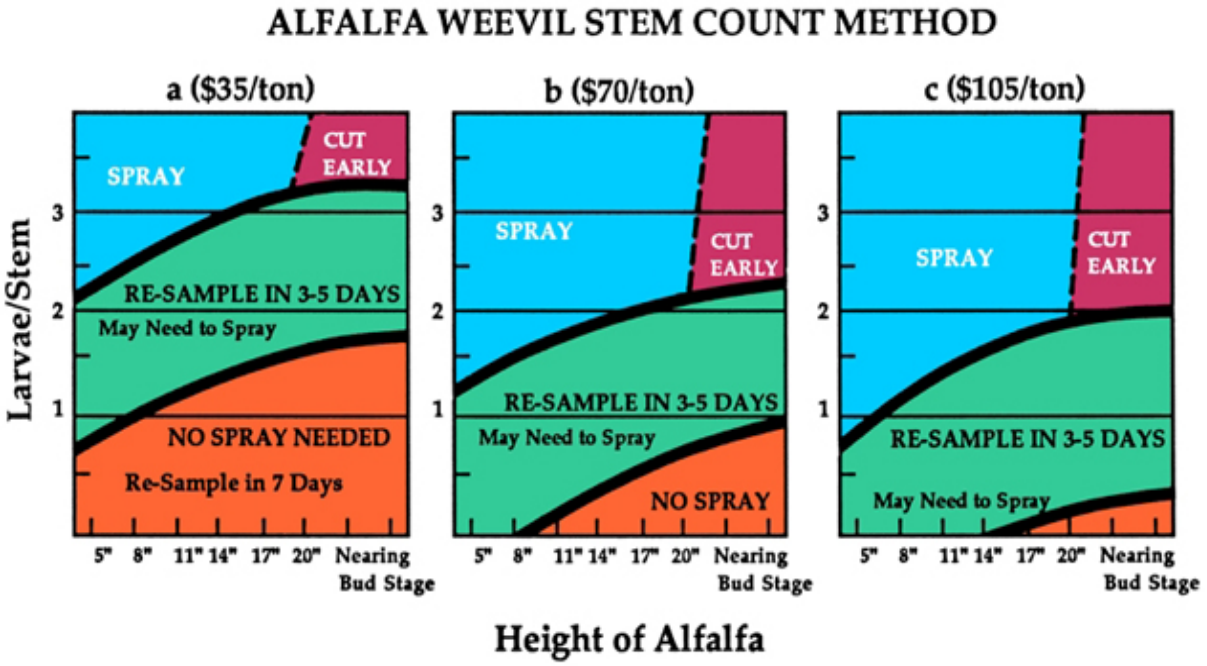


Figure 4. University of Nebraska economic treatment thresholds for alfalfa weevils utilizing the stem count method.

It appears as if the eastern U.S. is far ahead of the western U.S. in developing thresholds for treating alfalfa weevils. This may be due partially due to the intergrades of alfalfa weevil strains present in conjunction with highly variable altitudes where alfalfa is grown when compared with the eastern U.S.

Potential Future Methods of Monitoring

Several independent observations have noted that alfalfa weevil adults were much more numerous in alfalfa plots treated with several different pyrethroid insecticides from 4-14 days after application than untreated alfalfa or alfalfa treated with chlorpyrifos or other non-pyrethroid chemistries (Jarvi, 2003; Rethwisch et al, 2005; S. Orloff, pers. comm., UCCE-Siskiyou Co.). The exact reason for this is unknown, although speculation about faster development due to insecticide stress, and removal of beneficial insects exists. Examination of beneficial insect numbers in these plots during the same time period does not appear to negatively correlate with numbers of alfalfa weevil adults however (Rethwisch et al., 2005).

Application of pyrethoid insecticides may result in increased production of certain plant volatiles which could be similar to alfalfa weevil pheromones (Rethwisch et al. 2005).

Previous research of *Medicago* species (of which alfalfa, *M. sativae*, is a member) has noted the existence of at least three compounds (1-1methyl-4-(1-methylethyl) cyclohex-anol, (Z)-geraniol, and hexahydro-farnseol) which are similar to known insect pheromones (Core et al., 1994). Pyrethroid insecticide application to lettuce has been noted to affect physiological functions for at least 10 days after application (Sances et al., 1981), and may also affect alfalfa in a similar manner.

If this is indeed an alfalfa physiological response to pyrethroid chemistries, can this response as an adult weevil attraction be developed and utilized as an integrated pest management tool for monitoring adult weevil populations prior to oviposition?

APHIDS

There are four species of aphids that are of concern to alfalfa growers in the western U.S., with these being the pea aphid (*Acyrthosiphon pisum* Harris), blue alfalfa aphid (*A. kondoi* Shinji and Kondo), the spotted alfalfa aphid *Therioaphis maculata* Buckton) and most recently the cowpea aphid (*Aphis craccivora* Koch).

As with most insects and mites that attack alfalfa, greatest yield loss is generally associated with infestations that occur on early regrowth. The following treatment threshold levels from the University of California (Table 2) for several species of aphids which attack alfalfa illustrate this concept.

Table 2. Treatment thresholds for pea, blue alfalfa and cowpea aphids on alfalfa.

Plant height	Pea aphids	Blue alfalfa aphids	Cowpea aphids**
<10 inches	40 to 50/stem*	10 to 12/stem	10 to 12/stem
>10 inches	70 to 80/stem*	40 to 50/stem	40 to 50/stem
>20 inches	100 +/stem*	40 to 50/stem	40 to 50/stem

* See Table 3 for ratios of ladybeetles to aphids in determining if treatments are necessary.

**Thresholds have not been experimentally validated, therefore blue alfalfa aphid thresholds are suggested.

As can be noted from the table, the thresholds are dynamic and also take into consideration the presence of ladybird beetles (most likely convergent ladybird beetles *Hippodamia convergens).* Lady beetles need to eat many aphids per day so that they can lay eggs. The convergent lady beetle may eat its weight in aphids every day as a larva and consume as many as 50 aphids per day as an adult. Sevenspotted lady beetle adults may consume several hundred aphids per day and each larva eats 200 to 300 aphids as it grows (Cornell Univ.). Speciation of ladybird beetles may need to be completed and tables altered somewhat to account for the presence of sevenspotted lady beetles. This beetle species **also feeds on alfalfa weevil larvae**.

Table 3. Do not treat if the ratio of lady beetles to aphids is equal to or exceeds the following:

No. of lady beetles/sweep	No. of aphids/stem
ON STANDING ALFALFA	
1 or more adults	5 to 10 aphids
3 or more larvae	40 aphids
ON ALFALFA STUBBLE	
1 or more larvae	50 aphids

Treatment thresholds for spotted alfalfa aphid differ somewhat from that of other aphids. Part of this is due to the differences in biology and differences in time of year that these aphids attack alfalfa in comparison with aphids such as the pea aphid. This species and other alfalfa aphid species are also kept in check by a number of parasitic wasps, and attention to parasitism activity is highly recommended in order to make best decisions possible when regarding potential insecticide treatments.

Table 4. Treatment thresholds for spotted alfalfa aphid.

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 to 70 aphids per stem
Newly seeded alfalfa in lower desert	20 aphids per stem

* See Table 3 for ratios of ladybeetles to aphids in determining if treatments are necessary

CATERPILLARS

A number of caterpillars can affect alfalfa production in the western U.S. These caterpillars include the alfalfa caterpillar (*Colias eurytheme* Boisduval), beet armyworm *Spodoptera exigua* (Hübner), granulate cutworm *Feltia subterranea* (F.), variegated cutworm *Peridroma saucia* (Hübner). Caterpillars encountered less frequently include the army cutworm *Euxoa auxiliaris* (Grote), and the western yellowstriped armyworm *Spodoptera praefica* (Grote).

The feeding effects of the caterpillars vary as some species are primarily associated with quality reduction and then yield loss, while other species are more closely associated with yield loss.

Beet armyworms feed on foliage at or near the growing tips, leaving veins largely intact, and are primarily a foliar feeder which first affects alfalfa quality. First and second instar larvae tend to feed in clusters around the egg mass from which they hatch. Eggs are difficult parasitize because they are protected with scales from the moth's body.

Beet armyworm feeding frequently causes a tattered appearance of alfalfa terminals. This whitish appearance caused by the feeding is sometimes referenced as "whitecaps" and is very visible across a field. As the larvae mature and move to more stems, the areas of "whitecaps" tend to coalesce and the entire field takes on a tattered look. Control of this insect is difficult as only a very few insecticides can provide adequate control and therefore resistance is a concern.

Alfalfa caterpillars were very plentiful this past year in the low desert valleys in both Arizona and California, necessitating applications for control. This was not entirely surprising as outbreaks are often associated with hot, dry weather, and temperatures exceeded 120F on several days this summer in these areas. The exact relationship of this type of weather to outbreaks has not been fully investigated, but it may well be that extended hot temperature periods exceed thermal thresholds for survival of *Trichogramma* spp. wasps that parasitize alfalfa caterpillar eggs. A large outbreak of alfalfa caterpillars was also noted in 1996 in New Mexico and Texas, estimated to reduce hay yields by 0.5 tons/acre due to removal of large amounts of foliage by the caterpillars.

Granulate cutworms can be devastating pests of bed-planted alfalfa and can also be a pest of alfalfa planted between borders. Low desert alfalfa fields are attacked from May through October, but the pest occurs year round in fields. 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 due the caterpillars feeding primarily at night and hiding during the day. The problem becomes apparent when the field is irrigated and there is little or no regrowth.

This insect has been a greater problem than usual in the low desert valleys as well as the central valley of California in 2006. Although usually associated with bedded alfalfa production, these insects have usually been adequately managed in recent years via insecticide applications as flood irrigation is not an option for this type of production

system. PCAs in the low desert in 2006 report fighting these pests for a number of months, and concern about insecticide resistance exists. Insecticide bioassays are currently being conducted by the University of Arizona to determine if insecticide resistance the reason for difficulties in control. High temperatures experienced this summer may also be a factor, as adult moths usually deposit their eggs directly on alfalfa plants, and high temperatures may have reduced egg parasitoid wasps.

Variegated cutworms feed primarily at night on leaves and stems and hide in soil or under windrows of hay during daytime hours. Serious damage can occur on regrowth after the alfalfa is cut and larvae feed under the protection of drying windrows. They also can cut seedling plants in new stands. Larvae are variable in color, ranging from tan to greenish-yellow to almost black with a row of small yellow, dagger- or diamond-shaped spots down the center of the back. There are three to four generations a year.

Treatment should be considered if the hay does not begin to regrow in 4 to 7 days after cutting and larvae are present in the field. This insect is a frequent pest in alfalfa located in the Northern Great Plains states, but can be a problem in western U.S. production as well.

Army cutworms are usually only pests in areas east of the Rocky Mountains. In alfalfa, army cutworms will feed at the soil line on the developing new leaves just as they are emerging. Army cutworms feeding on alfalfa may cause delayed green-up, resulting in delayed harvest and possibly reduced forage yields. If the delay continues for extended periods of time, the stand may be in jeopardy, particularly newly-established stands. For established stands of alfalfa, **four or more army cutworms per square foot** are required to cause significant losses. However, newly seeded stands have fewer root reserves, and delayed spring green-up may be more injurious. Therefore, only **two larvae per square foot** could result in economic damage in new stands. If the alfalfa is growing well and recovering quickly from feeding damage, the cutworm infestation is probably inconsequential, and treatment is unlikely to be beneficial.

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