Alfalfa Weevil

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Alfalfa weevil adult, left; larva, right.

Alfalfa weevil is the most destructive insect of alfalfa hay in the intermountain western region of the United States. Both larvae and adults feed on the alfalfa; the larval stage is the damaging stage, lowering yield and quality.

Identification (and life cycle/seasonal history)

Adult weevils are snout beetles approximately $^{3}|_{16}$ inch long; they are light brown with a dark brown stripe from the head to about three-quarters down the back, narrowing as it progresses down the back. Older weevils may have a less distinct stripe. In colder regions where adults do not become active until spring, over wintering is thought to occur outside alfalfa fields. In warmer regions where adults are active during the winter, overwintering is thought to occur within alfalfa fields. When temperatures warm to about 48°F (9°C) in the spring, the weevils become active.

The females lay eggs a few days after emerging from over wintering sites. The females chew holes in alfalfa stems, laying from 5 to 20 eggs in each hole. The eggs are tiny, about $^{1}|_{50}$ inch long, oval yellow in color when first laid and turning dark brown before hatching. Egg clusters can be found by first checking for small punctures and splitting open the lower 1/3 of stems. Egg laying begins in April (warmer areas) or May (cooler areas, Montana) and extends through June or later. Each female will lay between 400 and 1,000 eggs.

New larvae hatch and emerge from stems after seven to 14 days, depending on temperature.
Weevil larvae are about $^{1}|_{20}$ inch long when they first hatch. They range in color from cream, to pale green, and are curved with shiny black heads. A white stripe running down the middle of the back may be visible and becomes more distinctive as the larva matures. At this stage a 10X hand lens is necessary to identify the weevil larvae. The coloration and shape is characteristic throughout the four larval stages, referred to as "instars." Fully-grown larvae are up to $^{3}|_{8}$ inch long and are wider in the midsection than at either end of the body.

First and second instars feed in the tightly folded leaves of stem buds. When half to full grown, the larvae tend to move onto open leaves near the terminals. Larval development is completed in about three to four weeks, with the peak damaging larval populations often coinciding with the first cutting of the crop. Fully-grown larvae move into the plant crowns and soil debris to pupate. The larvae spin loosely woven, net-like cocoons, in which they pupate.

Adults emerge from the cocoons in seven to 14 days depending on temperature. They feed on the alfalfa for a short time before entering a summer diapause or aestivation, reducing their activity for the rest of the summer. Adults may be found in protected sites in and around the field. There is one generation per year in the intermountain region of the United States. A second generation of alfalfa weevil may develop in warmer regions, but does not occur at economic levels.

Plant Response and Damage

Larvae feeding in the folded leaves can heavily damage stem terminals, but initial damage is not always clearly visible. The closed, overlapping foliage of the stem terminals should be unfolded to detect feeding damage. Heavily infested stands have a grayish or frostlike appearance due to the dried defoliated leaves. At high weevil densities, foliage can be stripped; leaving

only skeletonized and ragged leaf fragments and stems. Yield losses of 30 to 40 percent of the standing hay crop are possible under extreme feeding. This damage also may reduce hay quality due to loss of leaf tissue, leaving only the lower quality stems. Damage to regrowth buds may also occur when the plants first come out of dormancy and after first cutting. Larval feeding on the regrowth after first cutting may be concentrated in strips coinciding with windrow locations, if the first cutting was taken early due to heavy weevil infestation and if larvae survive under the windrows. Damage to regrowth may retard plant growth and result in yield reduction and encourage weed establishment.

Monitoring

Timing of sampling

Estimation of the weevil instars present in the field can be calculated using degree-days. Alfalfa weevil development increases at a nearly constant rate as the temperature rises above 48°F (9°C.). The amount of warm weather required for weevil larvae to complete development is measured in units of degree-days. For the alfalfa weevil, degree-days are accumulated after 1 March for each 24-hour period in which temperatures exceed 48°F (10°C). Using this technique **sampling should begin when 148 degree days have accumulated**. This timing coincides with the peak occurrence of second instars. In years of unusually warm or cold springs, weevil development may occur earlier or later than normal. The alfalfa weevil population relative to the estimated date of first harvest may influence management choices. Third and fourth larval instars cause most of the economic damage, so initiating sampling at the peak occurrence of second instars should provide adequate sampling prior to economic weevil populations

Table X-2. Accumulating degree-days of alfalfa weevil life stages, using a high-low thermometer.

1. Begin accumulating degree-days on March 1 or when temperature first exceeds 48° F. (the developmental threshold):

$$\text{Degree-days} = \frac{\text{Maximum temp.} + \text{Minimum temp.}}{2} ? \; 48 \; F$$

2. Add each day's accumulation to the previous total.
3. Compare the running total to the degree-days that correspond with recommendations for initiation of sampling.

Monitoring Techniques

Sweep sampling using a standard sized 38 cm diameter net is the most efficient method for estimating larval populations. Sampling should begin when 148 degree days have been accumulated, when the larvae are expected to be primarily second instars and when alfalfa hay has reached at least 10 inches in height. Ten, 180 degree sweeps are taken while the sampler is walking through the field. Count the number of larvae per sweep and repeat this sampling procedure, taking a minimum of three samples for fields up to 20 A, four samples for fields up to 30 A and five samples for larger fields.

Survey for alfalfa weevil larvae in a predefined pattern based on field acreage. Weevil infestation may be patchy or uniform depending on terrain, weather and soil. Inspection for weevils in every distinctive section of the field will aid in determining the pattern of the infestation.

Bucket method or stem count method is used to determine the number of weevil larvae per stem. Take three six-stem samples in fields one to 19 acres, four samples in fields 20 to 29 acres, and five samples in fields 30 acres and bigger. The tools and supplies needed for this method includes a three or five gallon light-colored bucket, a white cloth, a hand lens, paper and pencil. Use the following steps to survey and estimate alfalfa weevil densities (larvae per stem).

1. Walk into the field at least 20 steps from the field border, looking toward the horizon as you walk into the field (do not look at the plants).

2. At the first stop, bend over while still looking at the horizon and grasp the base of an alfalfa stem.

3. Cup the stem tip and gently break it from the crown (i.e. use care to prevent larvae being dislodged and lost before being

placed in the bucket).

4. Place the stem, tip first, into a white bucket. Repeat steps one through four to collect a total of six stems.

5. Grasp all six stems by their bases and vigorously shake them inside the bucket to dislodge larvae.

6. Count the number of larvae present, and record this number.

7. To obtain an estimate of larvae per stem for the entire field, divide the total number of larvae counted for all sampling sites by the total number of stems collected for all sampling sites.

Decision making

The economic threshold for a sweep sample is 20 larvae per sweep. The economic threshold for the stem sampling method is 1 ½ - 2 larvae per stem.

Calculating an economic threshold

1. Calculate the cost of insecticidal control in dollars per acre. Be sure to incorporate the cost of application with the cost of the insecticide.

2. Divide the insecticide control costs (dollars per acre) by the expected price for alfalfa hay (dollars per ton). The result is the expected yield in tons per acre that is the same value of the insecticide and application costs.

3. Select the larvae stem density from *Table X_1* that most closely corresponds to the calculated tons per acre yield that is equivalent to control costs. Use the first cutting column in *Table X_2* if only one cutting per season is expected and the total column if two cuttings are expected. The total column should also be used if additional cuttings beyond the second cutting are expected.

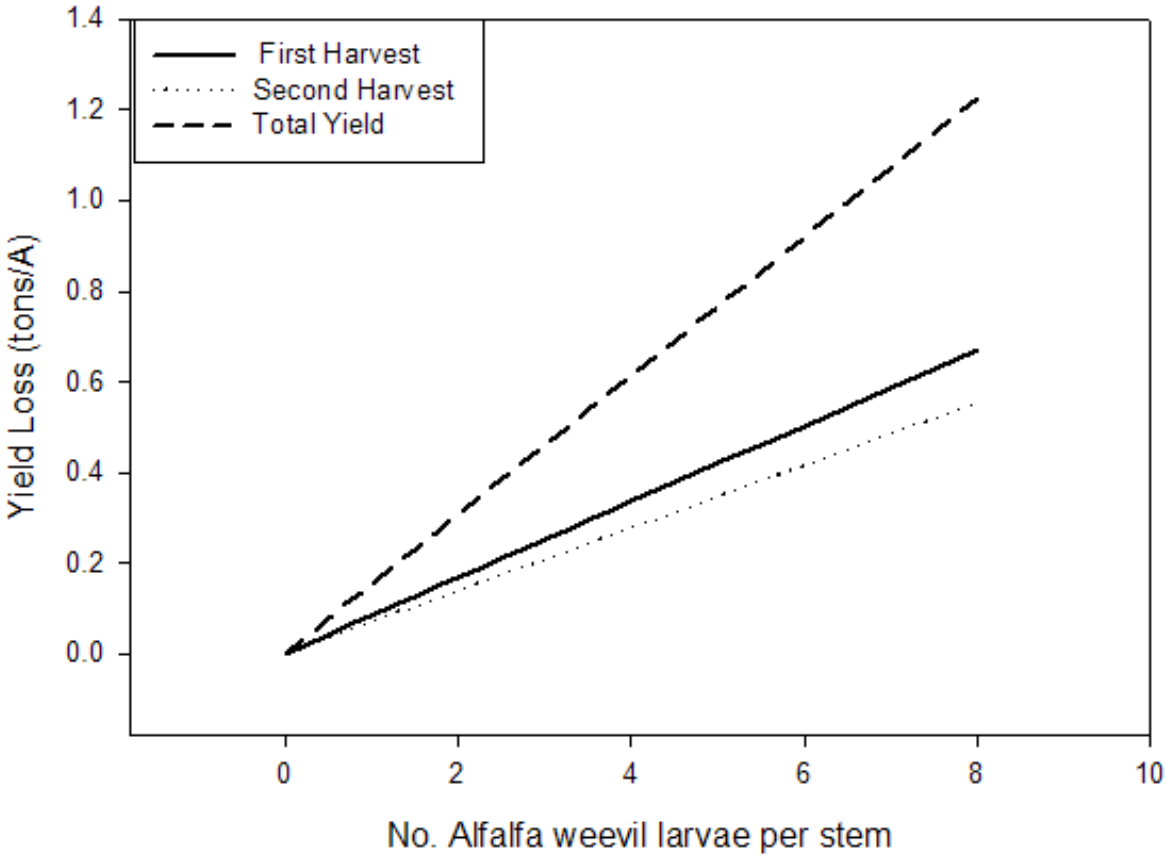
4. Scout each alfalfa field for larvae as described above.

5. Determine if insecticidal control is economically justified.
a. If the larvae per stem estimates obtained
in the field exceed the larvae per stem density calculated using *Table X_1*, the control will be economically advantageous.
b. If the larvae per stem estimates obtained in the field are the same or lower than the calculated larvae per stem density, control will not be economically profitable to pursue.

6. If an insecticide is to be used, consider effects on non-target organisms such as honeybees and natural enemies of the alfalfa weevil.

As an example using an average alfalfa hay price of $70.00 per ton and insecticidal control costs including application costs of $9.50 per acre, 0.14 tons per acre is the crop yield that is of equal value to the insecticide treatment. The 1.0 larva per stem density most closely corresponds to the 0.12 ton per acre value in *Table X_1*, assuming two cuttings will be taken. If the larvae per stem estimate you obtain in the field exceed 1.0 larva per stem, then the control will be economically advantageous. If the larva per stem field estimate is lower than 1.0 larva per stem, then the control will not be economically profitable to pursue.

Table X-1. Alfalfa Weevil expected yield loss, in tons per acre, for first and second hay cuttings on alfalfa up to 15 inches tall, based on densities of alfalfa weevil larvae per stem.



Management Approaches

Control measures should be considered when weevil populations increase to a point at which economic loss due to yield reduction is expected to exceed management costs. Insecticide applications and early harvesting are the most common growing season management strategies. If an economic infestation of third and fourth instar larvae is found when the plants are at 10 percent bud break stage or later, an early cutting (see below) is an alternative to insecticide use. But if larval survival under the windrow is high, stubble treatment may be necessary.

Cultural Methods

A non-insecticide control measure for alfalfa weevils is an early first harvest if an economic infestation is not detected until late in the growth of the first cutting. Harvesting alfalfa in an immature stage provides good control of larvae for the first crop. Rapid removal of hay will accelerate larval mortality due to desiccation by direct sunlight. An early first cutting tends to cure more rapidly because lighter windrows dry quickly, and forage quality is enhanced by higher crude protein and lower fiber content. Additional steps should be taken to ensure that surviving larvae do not cause economic damage to the regrowth. If larval survival under the windrows is high and baling is delayed (e.g., due to rainfall), damage to regrowth may be exacerbated. Regrowth should be inspected at a height of one to two inches to determine larval density.

Host Plant Resistance

Several cultivars of alfalfa (Arc, Perry, Liberty, Team, and Weevlchek) are moderately tolerant to alfalfa weevils. They tend to have a greater degree of auxiliary branching and have associated buds that continue to grow after stem terminals are defoliated by weevil larvae. No deleterious effects to forage quality have been found in cultivars that have some degree of tolerance or resistance to insect damage. Unfortunately, these weevil-tolerant cultivars have little resistance to the three most economically important alfalfa plant pathogens in the High Plains, Phytophthora root rot, Verticillium wilt, and stem nematode. Furthermore, the capability of tolerant cultivars to outgrow or keep up with weevil damage may not be sufficient to avoid the application of insecticides. Consequently, weevil-tolerant cultivars currently available are not considered to be a

viable alternative in this area.

Biological Control

Parasitic wasps have been considered the most effective biological control agents of alfalfa weevil. There are several species of parasitic wasps found in the High Plains. Some of these may be native to the region, but most have been intentionally introduced to control alfalfa weevil. Most attack the larval stage. The prominent larval parasitoids in our region appear to be *Bathyplectes curculionis* (mean equal to 34.5 percent parasitism from a three year survey in Wyoming) and *B. stenostigma* (mean equal to 3.7 percent parasitism from the same survey). *B. anurus* and an adult parasitoid released in the 1980s have been rarely detected in Wyoming and Colorado. For *B. curculionis*, variability of the parasitism rates (7.4 to 65.3 percent) was similar to that reported earlier in the 1970s (9.6 to 71.4 percent, mean equal to 26 percent). These rates of parasitism are not sufficient to eliminate the economic status of alfalfa weevil, but may be having a long-term effect in preventing alfalfa weevil from becoming a severe pest year after year in many areas.

Parasitic wasps can be recognized by a constriction where the abdomen meets the thorax (a "slender waist"), two pair of wings, and slender antennae measuring about one-third of the length of the body. Their body length is about $3\frac{1}{8}$ inch (9.5 millimeters) or shorter. They may be seen in flight among alfalfa terminals as they forage for alfalfa weevil to parasitize. Larvae with yellowing and deformed bodies may be an indication of parasite activity. This indicator should be confirmed by observing adult parasites. Combined with other cultural control practices, parasite activity may result in a weevil population's not achieving numbers sufficient to warrant insecticidal control. Unfortunately, the suppression of weevil populations is difficult to document, and there is little an individual hay grower can do to initiate biological control of alfalfa weevils. Biological control is enhanced by preservation of naturally occurring parasites and predators through reducing insecticide use when possible. If an early cutting of the first crop is a feasible alternative to insecticide use, parasites and predators will be conserved.

Chemical Control

If damage becomes unacceptable as harvest approaches, an early harvest or "rescue" insecticide treatment may be necessary. Use care in applying insecticide when alfalfa is approaching bloom: refer to the **Pollinator Protection** section for guidelines on minimizing insecticide contact of pollinators. Also, consider the waiting period before harvest for different insecticides. Generally, harvest or insecticide applications should happen before bloom if weevils are a problem.

Insecticide applications and early harvesting are the most common growing season management strategies. Research at Oklahoma State University has shown that alfalfa weevil present in the first crop can diminish yield and quality of the first cutting and can have a carry-over effect into the second hay crop. *Table X_1* in this section shows how much yield reduction for the first and second hay crop can be expected for various infestation levels when alfalfa is up to 15 inches in height.

Stubble treatments

After cutting and removing the hay, examine the stubble in several areas for evidence of continued feeding. Sift through the litter where the windrows were, checking in and around crowns for larvae, pupae, and adult weevils. *Table X-3* provides a calculation for determining if an insecticide treatment of the stubble would be necessary if regrowth will be delayed by alfalfa weevils, cloverleaf weevils or variegated cutworms. *Table X-3* calculates the number of days of complete defoliation that can be tolerated before an insecticide treatment will be economically warranted. The number of days will vary, depending on the cost of treatment, hay value and whether the hay is cut at first bloom or on a 28-day harvest schedule.

Table X-3. Alfalfa weevil (and variegated cutworm, clover leaf weevil) alfalfa stubble threshold calculation.

Factors	Example
A) Insecticide plus application	$7.00 costs (Dollars per acre)
B) Value of hay (dollars	$100.00 per ton)
C) Loss Factor (first bloom	0.0198 harvest = 0.0198)

D) Days if complete defoliation	3.5 that can be tolerated

To estimate D, multiply B by C, and divide into A. The example is calculated as follows: D = A/(B*C) = **7.00/(100.00*1.98) = 3.5**

Product List for Alfalfa Weevil:

Insecticide	**Product (Fl oz. or oz. product per acre)**	**Preharvest Interval, remarks**
Baythroid XL [R,1]	1.6-2.8	7 days. **Extremely Hazardous to Bees!** Do not apply to alfalfa in bloom. Maximum of 2.8 oz per acre applied per cutting. Total 11.2 oz/A applied per season.
carbaryl[1,2]	See labels	7 days. Most formulations **are Extremely Hazardous to Bees!** Do not apply to alfalfa in bloom. Sevin XLR+ is safe for bees if applied at <1.5 lbs ai/acre when no bees are in the field. Do not apply more than once or more than 1 7/8 lb per cutting
chlorpyrifos 4E[R,1,2]	16 ? 32	14 days (1 pt), 21 days (over 1 pt rate). Do not make more than 4 applications/year or more than one application per cutting. **Extremely Hazardous to Bees!** Do not apply when bees are present
Furadan 4F[R]	8 -32	7-28 days depending on rate. 1 application/season. **Extremely Hazardous to Bees!** Do not apply to alfalfa in bloom. Check label for other restrictions.
Imidan 70W	1-1.33 lb	7 days. 1 application/ cutting. Do not apply to alfalfa in bloom.
lambda cyhalothrin[**R,1,2**]	2.56-3.84	7 days for hay. Avoid application when bees actively foraging. Bee hazard when evening or morning dew. Do not apply more than 0.24 pt /A per cutting. Do not apply more than 0.96 pt/A per season. Advisable to move bees during application and allow 3 (low rate) or 5 (high rate) days before re-introduction of bees
Lannate SP, LV[R,2]	16 (SP) 48 (LV)	7 days to graze or feeding. Do not apply more than 3.6 lbs ai /season. Do not make more than 10 applications per crop. Highly toxic to bees, do not apply when bees are foraging.
malathion[2]	See labels	0 days. Apply to blooming alfalfa only in evening or early morning when bees are not working.
Mustang MAX[R,1]	2.24? 4.0	3 days. **Extremely Hazardous to Bees!** No more than 4 oz per cutting, 12 oz per season
permethrin	See labels	0 days. 14 days at rates greater than 0.1 lb ai. Do not apply more than 0.2 lb ai per cutting. Highly toxic to bees. Do not apply when bees are present.
Proaxis[**R,1**]	2.56-3.84	7 days for hay. Avoid application when bees actively foraging. Bee hazard when evening or morning dew. Do not apply more than 0.24 pt /A per cutting. Do not apply more than 0.96 pt/A per season. Advisable to move bees during application and allow 3 (low rate) or 5 (high rate) days before re-introduction of bees

Steward	6.7 ? 11.3	7 days. 12 hrs REI. Do not apply more than 45 oz/A. Minimum interval between treatments is 5 days.

RRestricted use pesticide 1 Labeled for chemigation 2 Generic active ingredient, several formulations

Categories: Alfalfa, Insects, Alfalfa weevil

Date: 02/27/2006