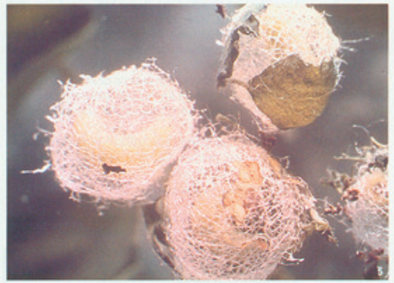

1. Dissected stem showing newly laid alfalfa weevil eggs.
2. Alfalfa weevil eggs about to hatch showing black heads of young larvae within.
3. Alfalfa weevil damage showing frosted appearance of untreated alfalfa strip.
4. Alfalfa weevil adult, pupa and 4 stages of larvae.
5. Alfalfa weevil cocoons.
6. Alfalfa weevil larvae consuming leaves.
7. Early spring alfalfa weevil damage.

Cover: Alfalfa weevil adult and oviposition hole in stem.

Cover photo & photos 1, 2, 6 by T.V. Myers, Lexington, Kentucky. Photos 4 & 5 by the University of Kentucky.

Making the Control Decision

When the sampling has been completed and the data averaged you are ready to make the control decision. The **economic threshold** for alfalfa weevil control is dynamic, changing with the height of the alfalfa. As crop growth increases, the amount of infestation necessary to cause economic loss also increases. Economic thresholds signaling the need for control if loss is to be prevented are listed in Table 1.

Once alfalfa weevil populations reach the economic threshold level, the application of an insecticide or harvesting are the only satisfactory methods of control, unless diseased larvae (larvae infected with *Erynia sp.*, a fungus pathogen mentioned below) are present. The grower has the choice of several insecticides to control the alfalfa weevil, depending on the amount of protection required. When 3 to 4 weeks protection is needed there are long residual materials which can be used. When harvest is expected within two weeks use a short residual insecticide. Some of the short residual insecticides are safe to use on pastures when applied according to the label. There is also a considerable cost difference between chemicals sold by the dealer, so it is important that the grower investigate and select the chemical that will best fit his needs at the least cost.

The performance of chemicals may vary in different areas. Consequently, recommendations vary between states. The grower should check with his local Extension Service for the materials and rates recommended in his area.

Other Alfalfa Weevil Management Practices

(1) Biological Control Agents: Parasites which are significantly contributing to the control of the alfalfa weevil in some areas include *Bathyplectes curculionis, Bathyplectes anurus* and *Microctonus colesi,* tiny wasps which attack the larvae, and *Microctonus aethiopoides,* a tiny wasp which parasitizes the adult weevil and renders it sterile. A disease caused by the fungus pathogen, *Erynia sp.* has become important in certain areas of the Mississippi and Ohio Valley states in Kentucky, southern Indiana and Illinois, east to Virginia. The disease also appears prevalent in certain areas of the Northeast. Where this disease or the parasites are abundant, chemical control may not be needed. Rarely will a second chemical application be necessary. In the case of *Erynia sp.*, infection by the disease is usually not prevalent until larvae are about half-grown and it does not appear to have much effect on early season larvae. Most mortality occurs after the population has peaked. Infected larvae are usually sluggish or dead, brownish in color and adhered to the alfalfa leaf. Growers should consult their local Extension Service entomologists regarding the prevalence of these biological agents and the need for alfalfa weevil control in their area.

(2) Agronomic Management: Practices which produce dense, vigorous growth reduce loss from the alfalfa weevil. Cutting and removal of the crop in the bud stage also reduces loss. **None of today's alfalfa varieties are resistant** to the alfalfa weevil. However, certain cultivars produce rapid growth and recovery in the spring which give them greater tolerance to weevil feeding than other varieties. Growing the best **adapted cultivars** for an area from **quality alfalfa seed** will help to minimize losses from the alfalfa weevil.

Heat Units[1]	Plant Height Inches	Stem Tips with Feeding	Decision
300	< 6	25%[2]	Reevaluate in 7 days. If the number of weevil larvae average at least one per stem and damage is increasing, spray with a long residual insecticide.
400	9	50%	Spray with a long residual insecticide if weevil larvae average one or more per stem.
500	12	75%	Spray with a short residual insecticide. If field is cut at this time, reevaluate field after cutting and treat within 7 days if weevils are still active.
600	15+ or bud stage	75-100%	Best to cut and remove crop; spray stubble within 7 days if weevils are still active.
750	Short or no regrowth	50% on regrowth	If no regrowth within 4-5 days of cutting and weevils are present, feeding on "bark" of old stems, spray immediately.
800			Beyond need for control measures. Weevil population gone or declining rapidly.

Table 1: Economic thresholds for alfalfa weevil pest management decision-making

(1) Heat unit accumulation above a base temperature of 48°F. from January 1.

(2) Counts of larvae in addition to feeding are advised since mortality of winter hatching larvae frequently occurs and treatment at this stage may be too early.

Above: Correct adjustment of sprayer boom for coverage and penetration of the foliage is necessary for alfalfa weevil control. The most satisfactory results are obtained with a spray volume of 20 gallons per acre.

Produced by:
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Manage the Alfalfa Weevil

to Improve Alfalfa Yield and Quality

No pest on the North American Continent spread more rapidly, or became a greater limiting factor in the production of a single crop than the alfalfa weevil *(Hypera postica Gyll.)*. This insect is now common to most alfalfa growing areas in the United States and southern Canada. In the 1960's and 1970's the devastation from the alfalfa weevil became so great that many growers gave up trying to produce alfalfa. However, advances in the management of this pest now make it possible to control it and produce high yields of a nutritionally high quality crop.

M. Curtis Wilson, Professor of Entomology
Purdue University, West Lafayette, Indiana

Description and Seasonal Cycle

The newly emerged alfalfa weevil adult is light brown with a dark line extending down the middle of the back. It is oval in shape, about 3/16 inch long and has a distinct snout. As it ages it darkens in color. With the exception of the clover leaf weevil, it is distinctly larger than most weevils found in alfalfa fields.

Female weevils deposit their eggs in alfalfa litter, stubble and fresh stems. Small scars can be observed on the stem near the ground surface where the female has made a puncture with her mouthparts; she deposits a cluster of eggs through this puncture into the hollow stem.

The number of eggs in a cluster ranges up to about 40 with an average of 9 or 10. The egg is very small, only 1/32 inch long, oval and light yellow when first deposited, but darkens before hatching. Over her lifetime, a single female may lay as many as 1500 eggs, but the average is between 600 and 800. Time of hatching depends upon the temperature, but in the spring eggs usually will hatch in 7 to 14 days.

The egg hatches into the legless larval stage. The alfalfa weevil passes through four of these larval stages, each time shedding its skin, before it is mature. After hatching, the larva emerges through the puncture in the stem through which the eggs were deposited. It climbs up the outside of the stem to the terminal growth where it begins to feed. The first stage is yellowish in color, with a black head, and legless. Despite its small size, it is extremely active at this stage.

As the larva develops, it becomes greener with each successive molt. The 4th stage larva is a shade of green similar to lush alfalfa with a white stripe down its back and a black head (in contrast to the clover leaf weevil which has a brown head). A full grown larva is about 3/8 inch in length. Normally, it takes about three weeks for the weevil to go through the larval stages.

When fully grown, the larva spins a cocoon on the leaves of the alfalfa plant or among debris on the ground. The larva pupates within this cocoon and the adult weevil emerges in about 10 days. Thus, the life cycle is completed. The adult feeds for a few weeks and then goes into a type of "summer hibernation" called aestivation, becoming inactive. There is only one large generation each year. However, all stages are sometimes present in small numbers throughout the season.

Damage

The alfalfa weevil is a foliage feeder. Larval damage starts with tiny holes in the terminal leaves. As the larvae grow larger, they move down the plants and feed along the edges of the fully expanded leaves. Heavy infestations will consume all the leaves, leaving only bare stems in the field. Larval feeding often causes the field to take on a gray frosted appearance. Weevil feeding not only causes loss in crop yield, but also affects crop quality. Leaf loss greatly reduces the protein content and digestibility of the harvested crop.

The alfalfa weevil is normally a first cutting pest, but in some areas may cause serious damage to the regrowth with resulting losses on the second crop. Furthermore, loss from the alfalfa weevil is not confined to the cutting on which it feeds. When not controlled, carryover effects from weevils on the first cutting reduce the crop's vigor and, consequently, yields of the subsequent second, third and fourth alfalfa cuttings (Figure 1).

The size of the weevil larval population and the time of its occurrence in relation to crop height is particularly important in determining the amount of crop loss that may occur. When alfalfa stem height is 12 inches tall when the weevil population peaks, fewer than 2 larvae per stem may defoliate a crop, but at a height of 18 inches it may take a population up to 14 larvae per stem to cause serious defoliation. The impact of timing on alfalfa yield loss is shown in Figure 2.

Many growers like the feeling of security they get by applying a control as insurance against loss, regardless of the size of the weevil population. However, this is self-defeating! In addition to the expense of $8 to $10 per acre for materials and application that is not needed, there are benefits from low infestations of the alfalfa weevil that are lost when faulty pest management procedures are applied.

Research has shown that small populations below the economic threshold not only do not cause loss, but may increase alfalfa yields. Low infestations appear to stimulate the alfalfa plant to produce more growth in an effort to keep ahead of the weevil's feeding (Figure 3). Furthermore, non-economic infestations provide a reservoir for survival of parasites and disease pathogens which suppress weevil populations and may keep them below the economic threshold.

Seasonal Development of the Alfalfa Weevil

Since the alfalfa weevil is so widely distributed across the North American Continent, it develops under a broad range of seasonal conditions. Furthermore, there are also two strains of the alfalfa weevil, known as the eastern and western, which vary in their habits. Consequently, damage from the alfalfa weevil and management practices may vary from area to area. In this leaflet discussion refers to management of the alfalfa weevil east of the Rocky Mountains.

The alfalfa weevil becomes active in alfalfa fields in October when it comes out of summer aestivation and begins to mate and lay eggs. Egg laying continues through the fall, ceasing as winter cold sets in, and commencing again in early spring when temperatures rise. Fall oviposition is of no consequence north of Interstate Highway 70 since few eggs or hatching larvae survive the winter in that region. However, south from this line, oviposition not only in the fall, but throughout the winter, becomes of increasing significance as the winter climate becomes milder.

Fall-laid eggs hatch before spring-laid eggs and early hatching larvae may destroy the crop by nipping the young plant buds before significant plant growth begins. Consequently, weevil populations reach an economic level much earlier in the growth stage of the crop in the South than in the North. In the North, damaging populations usually do not build up before the crop has 12 to 15 inches of growth, or may be delayed to the second cutting. Frequently, northern weevil populations peak close to harvest and cutting often becomes the most economical method of management.

Figure 1. Carryover losses to the 2nd, 3rd and 4th cuttings following a high infestation of the 1st cutting by the alfalfa weevil. Value calculated at $90 per ton. 1976 research data, Kenneth Flock Farm, Corydon, IN.

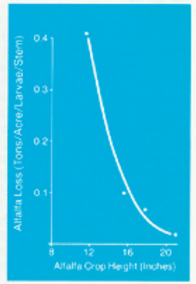

Figure 2. The shorter the alfalfa growth when weevil larvae peak, the greater the loss. Four-tenths ton of dry hay is the expected loss per acre when counts average one larva per stem at a crop height of 12 inches, but only one-tenth ton when the crop is 16 inches tall.

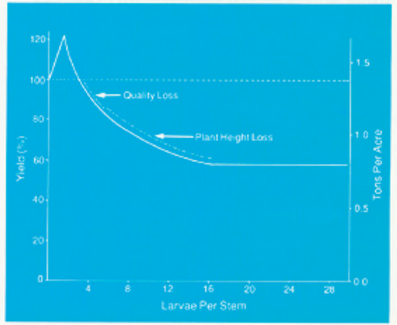

Figure 3. Effect of alfalfa weevil populations on yield, quality and height. Note that low numbers of larvae feeding on the crop throughout the season apparently stimulate the alfalfa to produce more growth. This occurs until the number of weevils get to a level the plants cannot tolerate and loss occurs. This graph represents total population over time until harvest. Numbers would be considerably less at any point in time.

The Use of Heat Units

The Extension Service in many states now makes timely alfalfa weevil management recommendations based on simulation models which predict development of both the crop and the insect. To understand this, let us look at one aspect of the alfalfa weevil model in its simplest form. Temperature is the most important factor in the development of the alfalfa weevil. There is a threshold temperature at which the insect begins to become active and develop. For the weevil this is approximately 48°F. Therefore, only temperatures above 48° are of interest for growth and development.

Knowing that each stage of the alfalfa weevil will reach peak abundance after a given heat unit accumulation, a simple program which accumulates heat units (or degree days) above 48° can be utilized for predictive purposes. An early peak of 3rd stage larvae from over-wintering eggs will occur after an accumulation of 325 heat units in the South and a second major peak from spring deposited eggs may follow at 575 heat units. Since weevil populations will peak and then must fall over time and the alfalfa crop as it grows taller can support more weevils, the economic threshold changes as the season advances. For example, when 300 units have accumulated there is not much growth on alfalfa and the weevils have just begun to feed. If larvae are present and 25% or more of the stem tips show feeding at this time it is important to apply a controlling spray within a week. But, at 600 heat units the alfalfa is tall and the weevil's development is so advanced that its numbers will soon decline. Consequently, there is no need to spray unless 75% or more of the stem tips show feeding. Cutting might be a better option for the grower.

Detecting A Problem

Although the alfalfa weevil is one of the most important pests of alfalfa, all fields usually will not have infestations high enough to warrant control measures. Each field should be surveyed to determine the degree of infestation before management decisions are made. Some states recommend making an estimate of the weevil population either by sweeping with an insect sweep net, or sampling stems and counting the number of larvae on them. In many states the Extension Service makes recommendations from economic thresholds based on the presence of larvae and the percent of stem terminals that show larval feeding at various stages of crop growth. Procedures for this methodology, which have generally been successful, will be discussed here.

In states where the Extension Service provides heat unit information, sampling for alfalfa weevil activity should begin when 250 heat units (150 in Oklahoma and adjacent states) have accumulated above a base of 48°F from January 1 and continue until controls are applied, or the weevil is no longer a threat. Where heat unit information is not available, sampling should begin as soon as the crop breaks dormancy and initial growth is observed, and continued at weekly intervals until first harvest. In the Southwest, consult the Extension Service in case sampling may need to be started sooner.

When sampling a field it is important that unbiased samples are collected. This is best accomplished by sampling at **random** from all areas of the field so that the insect population estimate represents not just a single corner, but the entire field. There are several sampling schemes which may be used, but the scheme chosen will vary, depending on the size and shape of the field. The important thing is to be certain that all areas (low flats, hillsides, etc.) are included. A sampling method must not only be **unbiased**, but **representative of the entire field**.

The M-shaped procedure is commonly used in fields which are nearly square (Figure 4). Using this method, 5 samples should be taken, one from each quarter and one from the center. Each sample should consist of a minimum of 6 (preferably 10) stems picked at random at soil level. When the field sample has been completed examine the sample and record the following information:

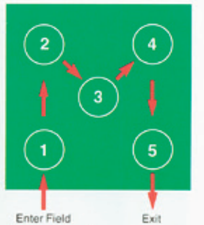

Figure 4: Sampling pattern for determining alfalfa weevil infestation.

(1) First, shake the larvae out of the stems into a bucket or pan to be certain they are present (see below) . However, tiny young larvae will not be dislodged this way. To ascertain their presence you must open the tiny leaves in the stem terminal. Count the larvae and average the number per stem.

(2) Examine each stem and record presence or absence of feeding in the stem tip. Feeding by young larvae may consist of no more than tiny pin-holes. When completed,determine the percent infested stems.

(3) Next, measure the length of each stem to the nearest inch. When this is done, total and average the measurements. This will give you the average height of the alfalfa.

(Continued on back panel)

Below: Collecting unbiased samples that are representative of the field is the **first** and **most important step** to making a pest management decision.